THURSDAY, JANUARY 21, 1897.

OUT-DOOR STUDIES OF NATURE.

The Round of the Year, a Series of Short Nature Studies. By Prof. L. C. Miall, F.R.S. Pp. 295. (London: Macmillan and Co., Ltd., 1896.)

Life in Ponds and Streams. By W. Furneaux, F.R.G.S. Pp. vi + 406. (London: Longmans, Green, and Co., 1896.)

BOTH these volumes, while aiming at scientific accuracy, are intended for the general reader; and, on this account, they have a considerable value.

Prof. Miall's "Round the Year" is quite an unique book. The study of a lofty model is sure to inspire us, intellectually or morally; and a close study of Gilbert White is manifest in most of his extremely interesting pages. They constitute a group of sketches growing out of the events of the year 1895; a year, in some respects, of unusual interest to the naturalist.

It is somewhat rare in these days to find a book, written almost entirely on biological subjects, so happily free from the laboratory, and its technicalities and methods. We see Prof. Miall as an observer, and by the very manner of his observations showing the amateur and the young mind interested in nature how to observe. This is aided rather than hindered by the very wide and even desultory character of the subjects which in this volume claim his attention. In the very first pages he introduces his reader to a fascinating account of some *Simulium larvæ*, found in "a clear and rapid stream which flows down from the moors of the Wharfe." This affords precisely the description of facts and circumstances likely to arrest and fix the attention of the hesitating as to whether or not he will make nature the subject of his special study.

These and the following few pages on insects and plants in midwinter are precisely what we need at this time. The amateur is diverted from the study of nature by the enormous mass of "facts" accumulated in the laboratory, having no doubt inestimable value, but compiled by men who, to those outside the specialist circle, appear little concerned with nature in the sense in which it was so beautiful to, and made so interesting by Gilbert White. The danger is lest we should, in modern days, cause the majority to conclude that the world must be divided into scientific and non-scientific; which in effect means into specialists and general readers. The intermediate order of mind, deeply observant of, and interested in, nature, is rarely considered. But it is to this class of mind that Prof. Miall appeals; and he does it with all the accuracy of a sound man of science, and all the simplicity of a natural lover of the objects he contemplates.

Some of the notes, such as "Snow-flakes," presenting as they do the latest results, will perhaps not be readily assimilated by the reader for whom these notes are really written; but ever and again we come upon the keen clear observations of a man as independent of text-books as he is of tutors: an observer whose observations will lead others to do likewise. His notes on "Phi and Theta"[1] are especially of this order, and while they incorporate the latest scientific investigation easily lead the non-scientific observer to see what possibilities of pleasant observation lie around him.

A very interesting paper is that on "Animals with and without Combs." "The Oil-Beetle (*Meloe*)" is another cluster of notes which we heartily commend to the general reader. But there is something quite fresh in "The Corn-rigs of Beamsley Fell," and in this we see the author's knowledge and love of Yorkshire.

Some very interesting matter not commonly thrown together is given on "The Cuckoo," in which the problem of the cuckoo's action in regard to her egg is very cleverly presented.

The "Botany of a Railway Station" is well worthy of the ordinary reader's study; and the notes on "Hay-time" and on "Moorland Plants" will quicken the interest of many in what is still known as "natural history."

The note on the "Reversed Spiral" is of great value; quite by incident, it will show the general reader how some of the most remarkable adaptations—"contrivances"—in nature are in reality not such. "The reversed spiral (with all its wonderful perfections of 'adaptation') is not a contrivance at all; it is a mechanical necessity when a band whose ends are not free to revolve is thrown into coils."

"The Structure of a Feather" and "The Fall of the Leaf" are not new, but clear and so presented that the readers for whom the book is written, and to whom it will be fresh, will find in it an uncommon interest. In short, this book worthily represents its author. A student of the deeper things of nature, he has pleasure, manifest in every page, in presenting to others the results of general observation, which may awake in them the keenest delight.

Mr. Furneaux's book on "Life in Ponds and Streams" is remarkably well presented to the reader. The publishers' work has been admirably done; and to those who have read "The Out-door World," there will be little doubt that in this book we have a thoroughly practical treatise. In fact this is not a book to "read"; it is a book to be taken as a guide to the practical study of the ponds and streams.

It was ponds and streams that led to the whole science of microscopic research; and whilst this book deals with the larger inhabitants of the pool and the brook, it is of exactly the order that is needed to awake an interest in living things far beyond the limits it has wisely set itself. The "introduction" is a useful epitome of the animal kingdom so far as it will be needed by the collector; and the practical hints and instructions on collecting are such as could only have been given by an experienced leader; and we may say that the careful reader of the chapters on "Collecting in Ponds and Streams" and "Collecting Minute Forms of Life," will not suffer much from embarking on his task with supreme trust in his guide. We think that the instructions given to the possessor of a moderately good modern microscope—and the English market is now crowded with the very best models at the very lowest price—as to how to make a "*spot-lens*" are, however, quite superfluous, for the simplest substage condenser ought to be supplied with

[1] A dog and cat.

the means of getting all the results the "spot-lens" can give, and we very heartily hope that even low powers are now rarely used without a suitable condenser. This, however, is a detail, and leaves the instructions to the tyro on this head with very little to be desired.

"The Pond Hunter's Museum" and "Aquaria and their Management," are both chapters of great value, and they are written by one who has realised the pleasures and the difficulties they involve. And after this we enter upon the supreme purpose of the book—the life which the pond and the stream reveals. For the purpose which the writer had in view it is not easy to conceive of a more practical and thorough treatment of his subject, and withal one which would enable the least initiated to follow more intelligently, and at the pond-side, what this book incites him to study.

It is not with the lower and minuter forms of life that the author chiefly concerns himself. These are lightly touched, affording ample room for future study. But worms, leeches, molluscs, crustaceans, spiders, aquatic insects, fishes and amphibians, form the main subjects of study.

In this region of study, as in all others, wonderful advances have been made. The pond-hunter of twenty-five years ago would have found a treasure indeed in a book like this. Its thoroughness and its admirable illustrations taken together give it a great value to the youth who happily determines to make the life of the pond or the stream his hobby; and if it never goes beyond that point, this volume will have served an admirable purpose. But the book is so well written, and is capable of inciting so much interest, that we believe it will accomplish a deeper and more lasting purpose

W. H. D.

THE LUNAR THEORY.

An Introductory Treatise on the Lunar Theory. By Prof. E. W. Brown, M.A. Pp. xvi + 292. (London: Cambridge University Press, 1896.)

THE design of this valuable text-book on the lunar theory is similar to that of Tisserand's "Mécanique Céleste," the object in both cases being to lay before the reader the methods by which various practical problems of gravitational astronomy have been attacked. In each case the recent pure mathematical investigations of Poincaré, Lindstedt, Gyldén, &c., though not passed by without notice, evidently form but a small part of the author's plan. Of the two writers, Prof. Brown is by far the least ambitious; and his work does not extend, like Tisserand's, to planetary theory, figure of the earth, precession, and other gravitational problems that form so large a part of the most recent "Mécanique Céleste." We venture to think, however, that Prof. Brown has dealt with his more limited subject in a manner that is far clearer, more thorough, and more useful to the student.

Prof. Brown has not attempted to follow any theory through all the approximations that are necessary for obtaining an orbit that shall represent the moon's path within the limits of observation, neither are the huge masses of figures necessary for such a task reproduced in the treatise. There is no mathematical point that cannot be sufficiently illustrated by the third approximation, or terms depending on the square of the disturbing force. The author has therefore limited himself generally to the first approximation, or intermediate orbit; to the second approximation, depending on the first power of the disturbing force; and to the third approximation, depending on the square of the disturbing force. In connection with the first approximation the author discusses the choice of an intermediate orbit, and in the case where this orbit is an ellipse he shows why it was necessary to modify it so as to represent the motion of the node and apse. Various elliptic formulæ are also given, including the application of Bessel's Functions. A theorem of Hansen's is also given, that is subsequently employed.

For a second approximation the author shows that in practice the earth's mass may be neglected in comparison with the sun's, and that subject to a simple modification in the final result the moon's mass may be neglected altogether, or rather assigned to the earth. A numerical estimate—which we believe is original—is given of the magnitude of the errors involved in these assumptions. In this connection we should like to enter a protest against the calculation of terms depending on the square of the sun's parallax when the moon's mass is neglected. The modification, above referred to, does not correct these terms; they cannot in any way be made to represent an actual phenomenon: they are, as it happens, small enough to be negligible—were this not so, the method would have to be altered in order to compute them.

The disturbing function is also developed in different ways suitable for different theories. The differential equations of disturbed motion are also obtained. In the integration, various points are carefully discussed. The most important of these is the way in which terms proportional to the time might occur, the way in which such terms are got rid of, and the interpretation of this artifice—due to Clairaut—as representing a motion of the node and apse. Another point is the meaning of the constants of integration; when, for instance, the motion is no longer elliptic, the notion of the eccentricity becomes somewhat vague. In order to render two theories comparable, the arbitrary constants of one must be expressed in terms of those of the other; and hence it is desirable in every theory to have a clear conception of the meaning—if possible the physical meaning—of the constants. Again, at every fresh approximation fresh constants arise as part of the "complementary function." What to do with these constants requires careful consideration; sometimes one has to be left arbitrary for a time, in order that it may be used later to remove terms depending on the time; more often—and the preceding case is really only a special case of this—they may be used to suitably modify or to define more exactly the constants that have previously arisen. These points are of fundamenta importance, and are rightly dealt with by Prof. Brown at considerable length.

The difficulties of a third approximation chiefly consist in the necessity for computing the disturbing forces with the disturbed coordinates already obtained. An example is given from De Pontécoulant s method.

Prof. Brown also discusses the general form of the final result. Every argument must be the sum or difference of integral multiples of four angles, and the characteristic of each coefficient—that is to say, its order in the eccentricities, inclination, and solar parallax—can be written down by inspection, and is not modified by any integration or other process that occurs in the computations. The order, however, in the ratio of the mean motions does not follow any simple law. This is due to the fact that certain terms rise in importance on integration. The class of terms that behave thus is carefully pointed out in the book, and the fact that their consequent increase in importance is transmitted to the terms in *queue* with them, thereby doubling the number of approximations necessary, is noticed. As far as we know, the whole question has never been thoroughly gone into, so as to form rules whereby the order in the mean motions of every term may be estimated. It would form a fitting subject for a thorough investigation. For instance, with Delaunay's notation, the term with argument 2D is of order m^2, the term with argument $2D - l$ has been lowered by one order in m to me. The term in $4D + l$ may be considered as made up of $2D + 2D + l$, $2D + (2D - l) + 2l$, or $(2D - l) + (2D - l) + 3l$, and its order will be m^4e, m^3e^3, m^2e^5 in the three cases. Similarly the order of the term in $4D - l$ is m^3e and m^2e^3. These are simple cases illustrating the fact that lower powers of m often occur than the power by which the characteristic part of the coefficient is multiplied.

The treatise deals with four theories in some detail—De Pontécoulant's, Hansen's, Delaunay's and Hill's. De Pontécoulant's is an easy one to understand, and the author has attached to it his discussions of the constants and other points that are in reality common to all theories in variously modified forms.

Hansen's theory is an extremely difficult one, and Tisserand has entirely failed to give an intelligible account of it. Prof. Brown, too, leaves something to be desired; but we at least owe to him a remarkable simplification in an introductory lemma (recently published in the *Monthly Notices*). The proof given by Prof. Brown is so simple, that its merit is only apparent to those who have read Hansen's investigation of the same point. Hansen's theory is of a curious design: the inequalities are thrown upon the time or the mean longitude. Dr. Hill considers that the method was an outcome of an extension to all terms of a method used by Laplace for terms of long period.

Delaunay's theory is a gigantic task representing twenty years' labour. His method is the variation of arbitrary constants, using canonical equations. Prof. Brown has considerably simplified the introductory analysis on which the theory rests, and has recently published a further simplification in the *Proceedings* of the London Mathematical Society.

Dr. Hill's theory is the most recent, and the simplest in form. It is, however, as yet far from complete. It was, as is well known, originated by some papers of Dr. Hill's in the first volume of the *American Journal* and the eighth volume of the *Acta Mathematica*. In these papers Dr. Hill obtains the variation curve (that does duty as the intermediate orbit) and the motion of the perigee. The further development has been left almost entirely to Prof. Brown, who has published a series of papers in the *American Journal*. Among these is a paper of great analytical interest containing some theorems that include two famous theorems of Adams' as special case. It is much to be wished that Dr. Hill's theory should be completed.

The book concludes with a short sketch of several other theories, and the methods used in computing inequalities other than those due to the sun.

OUR BOOK SHELF.

Chemistry for Engineers and Manufacturers. A Practical Text-book. By B. Blount and A. G. Bloxam. Vol. ii. *Chemistry of Manufacturing Processes.* Pp. 484. (London: C. Griffin and Co., Ltd., 1896.)

IT is stated in the preface that the sole object of this work is to give the reader a general view of the principles which underlie the several manufactures described. The ground covered is very wide, so that in order to keep the book within reasonable limits a very condensed style has been adopted. The opening chapters deal with the manufacture of sulphuric acid and alkali, and the destructive distillation of coal, wood, and bone, the account of coal-gas manufacture being especially well done, although the short account of methods of gas-testing is sketchy and inadequate, and might have been omitted with advantage. The subjects of artificial manures, petroleum, cement, glass and porcelain, sugar and starch, brewing and distilling, oils, resins and varnishes, are next dealt with. The soap and candle industry is dismissed in nine pages, no account being given of the chemistry of the "cold process" of soap-making, in which the excess of alkali is eliminated by the subsequent addition of ammonium salts, although most of the highest grades of toilet soaps are now prepared by this process. The chapter on dye-stuffs, which follows, contains a good synopsis of the chemistry of this subject. It is, however, too brief to be of much service to the dye-works chemist, and is certainly beyond the apprehension of the average engineer.

The authors, indeed, are rather optimistic in their estimate of the chemical knowledge possessed by engineers, as chemical formulæ and equations are freely used throughout the book. Of the remaining chapters, those dealing with the preparation of pigments, leather, and explosives are the most important. In view of the growing importance of cyanide compounds in gold extraction, it is to be hoped that a little more space will be found for this subject in the next edition, no mention being made of the recent advances in the industrial applications of the well-known synthesis from alkalis, carbon, and gaseous nitrogen. The short bibliography at the end of the book will prove useful in following up the details of any particular subject.

The Struggle of the Nations. By G. Maspero. Edited by A. H. Sayce, and translated by M. L. McClure. (Society for Promoting Christian Knowledge, 1896.)

SOME time ago (see NATURE, No. 1310) we called the attention of our readers to the issue of a much enlarged and illustrated edition of M. Maspero's work "Histoire Ancienne des Peuples de l'Orient Classique" in a notice of the first volume, which appeared in England under the title of "The Dawn of Civilization," and we welcomed it as a book much to be desired. The second volume now before us is the next instalment of the edition, and we welcome it no less gladly; it is to be hoped that the intervals between the issue of the volumes will become shorter and shorter, and that the whole work may be in our hands in a few years. The period covered by the first volume extended from the time when we first have written records in Egypt and Western Asia (including Babylonia) to the end of the reign of the kings of the twelfth dynasty in Egypt, say about B.C. 2500; in this volume we are led from the time of Khammurabi and his immediate predecessors to the end of the twenty-first dynasty, about B.C. 1100. The nations discussed in the earlier volume were comparatively few, but when we turn to the later one we see that it treats of the history of all the peoples who lived in the countries which lie between Elam on the east, Cyprus on the west, Armenia on the north, and Berber on the south. How they arose, gained power, made war and invaded each other's territories, attained the zenith of their glory, were conquered, and were finally destroyed or merged in the ascending might of their neighbours, M. Maspero has undertaken to tell; and we think that he has carried out his task very fairly well. The overwhelming mass of notes and references to authorities testify to immense energy, and to a desire to put the reader in possession of a large number of facts. In the course of his work he has touched upon a variety of "burning questions," such as the Hyksos, the Hittites, the Exodus, &c., and we are tolerably certain that he will not please every one who reads his book; on many points we ourselves should disagree with him. To discuss these differences would require more space than we are allotted, and it is only fair to say that the general plan of the work is excellent, and that the author has spared no pains to make it a useful guide to the knowledge of Oriental history. On certain subjects his information is not obtained at first hand, but when we consider that he has to deal with Egyptians, Babylonians, Assyrians, Cosseans, Kassites, Elamites, Hittites, Arameans, Syrians, Hebrews, and others, this cannot be wondered at; and that he should be led away, at times, by his authorities is quite excusable. His chapters on Egyptian history are, as might be expected, worthy of his reputation.

The Camera and the Pen. By T. C. Hepworth, F.C.S. Pp. 64. (Bradford: Percy Lund, Humphries, and Co. Ltd., 1896.)

RELIEF blocks produced without the aid of the engraver are now extremely common—rarely do blocks of any other kind appear in NATURE—yet it is astonishing how very hazy are the ideas which the majority of people have as to the way they are made. In this slender volume will be found a sketch of the methods employed to produce line blocks and half-tone blocks, and we trust it will be widely read; for a knowledge of the possibilities of process work would often save the production of a bad block. The simplest form of process block is that made from line drawings, or pen-and-ink sketches. To obtain the best effect, the drawing should be made on Bristol board, or similar white surface, in very black ink. Liquid india ink is commonly used, but Stephens' ebony stain is sometimes preferred. This is photographed by the process worker, and, by a simple arrangement, a reversed negative is obtained. A sheet of zinc, covered with a substance which becomes insoluble after exposure to light, is placed in contact with this negative, and afterwards the unaltered parts are washed or rubbed off. The zinc plate thus marked is then etched, and eventually mounted on wood ready for the printing machine. It will be evident, then, that drawings to be used for the production of blocks in this way should be very distinct, and no lines or marks should be upon them but what are required to appear in the figure. The half-tone process is used for the reproduction of pictures other than line drawings. For illustrations of natural things and phenomena, where accuracy is all-important, reproduction by photographic process may be said to be essential. The only conditions for satisfactory results are clear pictures, which may be either negatives or positives.

Many hints of interest to photographers, as well as very instructive information on the processes of manufacturing blocks for illustration purposes, will be found in Mr. Hepworth's book. The only complaint which is likely to be raised about the contents is that they are deficient in details.

LETTERS TO THE EDITOR.

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Bog Slides and Debacles.

THESE slides have been brought very prominently forward on account of the recent debacle near Gneevegullia, Co. Kerry. They are a subject that ought to be known and understood, as numerous observers and writers have brought the subject before the public since Gerrard Boate wrote on bogs in A.D. 1652, up to the present time.

If, however, we are to judge from what has been lately written, the public seem to be supposed to consider such a slide as that in Kerry as something quite out of the common, which no one can understand. But, on the contrary, bog slides and debacles are one of the numerous Irish disturbances, that lie dormant for a time and burst forth suddenly when least expected—take Gneevegullia Bog as an illustration. It is situated on the watershed of the Brown Flesk, a tributary of the Maine, the Blackwater and the Flesk, into all which rivers at times it sent squirts, but especially in late years, into the Quagmire River, a tributary of the Flesk. Into the latter river it sent a considerable squirt three or four years ago; now it breaks forth into the Flesk instead of the Brown Flesk; where it was always expected to go.

Small slides and debacles of both bogs and drifts, in the Irish hill groups, are not uncommon, and any frequenter of the hills must at some time or another have seen one. They give the observer a very nasty sensation. Suddenly he sees a curious shiver in a bog flat; at first he considers it to be only the shimmery air over the bog, so usual in hot weather, but presently he sees a "creeping where no life is seen," with a black steam or sheet issuing from it. Ten to one he immediately jumps up to make sure that his seat has not also taken to walking. Most bog slides are hard to see, as they usually take place during the night; there are, however, exceptions to this general rule, as the famous slide in the Ballykillim Bog, near Clara (1825), took place while the turf-cutters were at their dinner, and the slide on March 28, 1745, near Dunmore, Co. Galway, also took place in the day-time, and the turf-cutters had to run for their lives.

In the annals of the Four Masters there are records that must refer to either water-spouts or bog debacles, but they are too vague to quote. Gerrard Boate, in 1652, tells us how to drain a "shaking bog," but he does not record any movements. The first I know of is the communication to the Royal Society in 1697, by W. Molyneux, of the Bog of Kapanihan, Co. Limerick, near Charleville. As this began at 7 p.m. on June 7, 1697, the first movement of this bog could be described; afterwards he gives the final results, and the causes that made the movements. The newspaper reports at the time talk of the accompanying great noise; Molyneux, however, says there was none. The Bishop of Clogher also gives a good scientific account of a bog movement near Clogher on March 10, 1712; but the majority of the other records are by men who have gone in for sensation. This has been the case in the recent reports. No one knows when the movement began in the Gneevegullia Bog, but now we are told it was heralded in by noises and great shaking.

The printed records of big slides or debacles that I have read (as far as I can remember) are the following:—

1607. June 7. Kilpaniham, near Charleville, Co. Limerick.

1708. Castlegarde, Co. Limerick.

1712. March 10. Near Clogher. This bog had also moved, according to tradition, before 1640.

1745. March 28. Addergot, near Dunmore, Co. Galway.

1780. Monabogh, Dundrum, Co. Tipperary.

1819. Valley of the Owenmore, Erris, Co. Mayo.

1821. Slip in Joyce County, Co. Galway.

1824. December 22. Ballyroindallow Bog, near Coleraine.

1825 (?). Kilmalady Bog, near Clara, King's Co. Fasset Bog, 16 miles away, also moved, but did not burst forth.

1867. Glen Castle Hills, Belmullet, Erris, Co. Mayo.

1871 (?). In the Valley of the Suck, alongside one of the Roscommon tributaries.

1871 (?). Clonagill, near Birr, King's Co.

Other big slides will be found recorded by Lewis, but it would take time to go over all his County histories.

Every slide and debacle is due to the combined effects of great drought succeeded by heavy wet. In the majority of the bogs, of any extent, and even in some of very small dimensions, there are in parts "shaky bogs." Those portions in great drought dry and contract, thereby being traversed by fissures, and more or less broken away from their soles. When the rains descend and the floods come, the water first saturates and floats the lower portions and afterwards the upper portions. The latter process has a peculiar appearance. When a bog is saturated, on its highest part there is generally a Loughaun, *i.e.* a pool without any surface outlet. During a drought the bog about the Loughaun sinks, while it often becomes quite dry; but when the rains come, the bog swells just like a dry sponge put in water, and rises the Loughaun along with it. When a bog is saturated its lower portion is a sea of mud surrounded by a hard margin. If this margin in any place gives way there is a bursting forth ("debacle"), as in the recent case in Kerry, but sometimes the bog will over-swell, as in the case described by Molyneux, when the bog will begin "to walk" on its own account, and in its course lift up and carry away the barrier.

Different slides, such as that near Clara, that near Dunmore, and the recent one, were due to the turf-cutters, who weakened the barriers. Turf may be cut on two systems—"Brest banks," or banks opened round the margin of a bog or along a road; and banks that are more or less perpendicular to the margin of a bog or a bog road. The latter class of banks prevent slides, as they act as drains to the mass of the bog; while the Brest banks facilitate slides, as possibly may be exemplified this coming season, when the Brest banks are being cut.

Naturally it will be asked why all the bogs are not cut on the perpendicular system? The answer to which is, that it has been generally adopted in the mountain districts; but in the Low Land deep bogs this is nearly impracticable, as it would take years before you could run your bank into them, while all the time you would be at a dead loss. This, however, is a subject outside the present inquiry.

During my years of tramping the Irish hills, I have seen some interesting aspects of bog and drift slides; but it is unnecessary to recapitulate them here, as any one interested can fully read up the subject in previous publications.

It may, however, be allowable to point out that the different writers on the late Kerry debacle, apparently never saw the site of a previous debacle, or they would not make the foolish suggestions that have appeared in their writing.

I visited the Owenmore site about 1875, or about fifty years after its occurrence. This is the most disastrous slide on record, as it carried away a whole village and its inhabitants, also a picket of Highlanders, whose bodies were afterwards pinked up in Tullaghan Bay. When I saw it there was nothing very remarkable about the bog; it had a nice hollow in it, with a pollagh for snipe and duck; but if I had not been told to the contrary, I would have seen nothing very extraordinary about it. Of similarly other sites that I have visited, that in the Joyce country is now a heathy hollow, a good place for grouse; while that on the Glencastle Hill slope, when visited ten years after, could scarcely be detected, except that at the north end of the townland, adjoining the road and Broad Haven, there was a tumbling up in hummocks, partly drift, partly bog.

A new gulch, due to a debacle, is hard to cross, if not impassable, for a year or two; after which time the bog will have soaked, and the bog-mould slopes will begin to consolidate and grow vegetation; once they have a sod on them all appearances of the debacle rapidly disappear, so much so, that only one person out of a hundred, if you undertook to explain to him what had formed a gulch in a mountain slope, would believe you; the other ninety-nine would say "Hookey Walker!"

The bog, the site of the recent slide, is not more than 20 or 30 feet deep; this will contract at each side of the gulch so as to leave a hollow not more than from 10 to 15 feet deep, as has elsewhere been practically proved.

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On the Goldbach-Euler Theorem concerning Primes.

I HAVE verified the new law for all the even numbers from 2 to 1000, but will not encumber the pages of NATURE with the retails. The approximate formula hazarded for the number of resolutions of $2n$ into two primes, viz. $\frac{\mu^2}{n}$, where μ is the number of mid-primes, does not always come near to the true value. I have reasons for thinking that when n is sufficiently great, $\frac{\mu^2}{2n}$ may possibly be an inferior limit. The generating function

$$\left[\Sigma \frac{1}{1-x^p}\right]^2$$

given in a recent number of NATURE, p. 196, is subject to a singular correction when the partible number $2n$ is the double of a prime. In this case, since the development to be squared is

$$\mu + x^n + x^{2n} + \ . \ . \ . + x^p + x^{2p} + \ . \ . \ . +, \&c.,$$

the coefficient of x^{2n} will contain 2μ, arising from the combination of o with $2n$, which is foreign to the question, and accordingly the result given by the generating function would be too great by 2μ.

This may be provided against by always rejecting the centre of the mid-range from the number of mid-primes. The formula will then in all cases give twice the number of ways of breaking up $2n$ into two unequal primes. Another method would be to take as the generating function not the square of the sum, but the product of the fractions $\frac{1}{1-x^p}$ (without casting out n when it is a prime), but this method would be inordinately more difficult to work with in computing series involving the roots of unity than the one chosen, which is in itself a felicitous invention.[1] Whether the method turns out successful or not, it at the very least gives an analytical expression for the number of ways of conjoining the mid-primes to make up $2n$ without trial, which in itself is a somewhat surprising result. Having lost my preliminary calculations, it may be some little time before I shall be able to say whether the method does or does not contain a proof of the new theorem; but that this can be ascertained, there is no manner of doubt. This is the first serious attempt to deal with Euler's theorem, or to bring the question into line with the general theory of partitions.

It is proper to regard the range 1 to $2n-1$ as consisting of two complementary flank regions, two lateral mid-prime regions, and a region reduced to a single term in the middle, as *ex.gr.*

$$1, 2, 3 : 4, 5 : 6 : 7, 8 : 9, 10, 11.$$

Or, again,

$$1, 2, 3 : 4, 5, 6 : 7 : 8, 9, 10 : 11, 12, 13.$$

And the question of $2n$ being resoluble into 2 primes breaks up into three, viz. whether $2n$ can be composed with two flank primes, two lateral mid-primes, or with the number in the central region repeated.

Some slight corrections are required in the preceding note in NATURE. P. 196, l. 5 of letter, for "improved method" read "original method"; l. 7, for "demonstration" read "denumeration"; l. 24, omit the words "with the exception of $2n = 2$." Also, p. 197, l. 3, for "ρe^θ" read "ρe^t."

January 1. J. J. SYLVESTER.

Patterns produced by Charged Conductors on Sensitive Plates.

IN the course of a recent X-ray lecture demonstration, I accidentally got what is, so far as I know, a novel, and certainly an interesting result. Having taken a radiograph of three small wire skeletons enclosed in cardboard bodies, on the developed plate (covered with a plain glass pressed upon the film) being put into the lantern, I noticed the precipitated silver particles set themselves in certain lines. These radiated normally from the skulls and limbs of the figures, and in the more open parts of the background set themselves into a key or fret pattern. I concluded, on further examination, that this effect was probably due to a state of electric strain induced by the Röntgen tube, but it was only upon the softening of the gelatine film by the heat of the lantern that the particles were set free, so as to obey the electric impulse to which they were subjected.

This led me to experimer upon the effect produced by charged conductors on sensiti plates, with the final result of

[1] For the generating function we may take any power greater than instead of the square, and the coefficient of x^{2n} will then be the number of couples making up $2n$ multiplied by $(r^2-r)\mu^{r-1}$, which can be calculated by the same method as for the square, but is more difficult and must give rise to numerous theorems of great interest, arising from the multiform representation of the same quantity.

securing very perfect images of the invisible electric discharge without the plates being exposed to either X-rays or light.

This discharge—or possibly, more strictly speaking, the electrified streams of air driven off by it—appears to act upon the plate exactly as light does. It is thus possible to secure

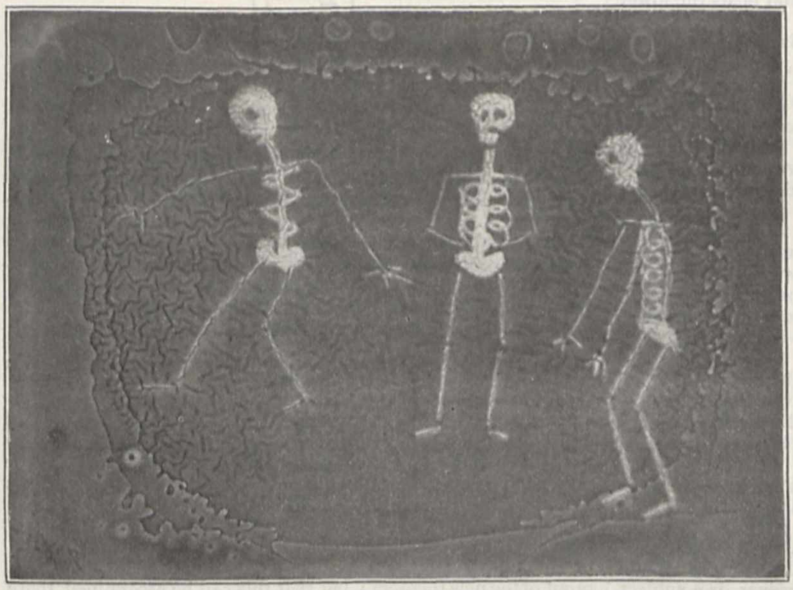


FIG. 1.

impressions of such discharges by simple electrification and subsequent development.

Under certain conditions very perfect images of the relief upon coins and similar objects can be obtained. This seems to

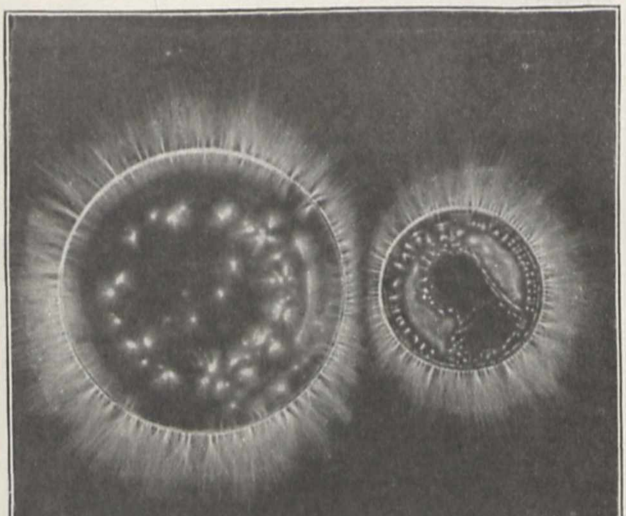


FIG. .

account fully for the fact that in some cases radiographs of coins have shown some trace of the design upon the under side which was in contact with the film.

I enclose prints of the radiograph showing the set of the silver particles around the skeletons, which effect I have since reproduced, and also of what I think may properly be called electrographs of coins, and of discharges from metallic points and surfaces.

I should be glad to know if any similar results have come within the experience of any of your correspondents.

Fig. 1 is a radiograph of wire skeletons enclosed in cardboard figures, developed and fixed, covered with glass plate, and put in lantern. On the heat of the lantern softening the film, the precipitated silver particles set themselves in pattern. The explanation which suggested itself was that this was an electrical effect induced by the Röntgen tube, but I cannot definitely assert that this is the case. It is conceivable that the segregation of the particles may be due to some other play of forces, such as unequal tension in the film; but the first idea seems the most probable. I hope to test this further by experiment. I have reproduced a similar pattern, though not quite so perfectly as in this instance. The irregular edge is the result of the partial drying of the film.

Fig. 2 represents an aluminium medal and gold coin. The coins were laid upon a photographic dry plate, enclosed in a cardboard box, electrified for two seconds from one pole of a small induction coil, and developed. Brush discharge round margin very fine, the discharges from the two objects repelling each other. The larger was in high relief, and the lettering has produced small brush discharges. Some shaded ground in recessed part of coin, probably due to the electrified film of air, confined within the margin of the coin, resting in contact with the plate. JAMES I'ANSON.

Fairfield House, Darlington, January 7.

The Force of a Pound.

PROF. PERRY, in his review of my "Elements of Mechanics" in your issue of November 19, 1896, gives his method of explanation of mechanical units to engineering students.

The method is almost as perplexing as the one he so severely condemns. The source of confusion in both cases is in attaching the term "mass" to the ordinary gravitation system—the system of "weights and measures." Engineers have no need of the term; in its strict sense it is foreign to their work. The engineering unit of quantity is the "pound," as determined by the process of weighing against standard weights.

The engineer deals mainly with bodies at rest, or moving with uniform speed. The system sufficient for him is therefore not sufficient for the physicist, to whom the idea of acceleration is fundamental. The physicist notices that bodies possess a certain quality determinative of acceleration, and to this he gives the name *mass*. Masses are thus to be compared by kinetical methods, fundamentally at least. The term "mass" belongs to the system of the physicist, the so-called absolute system, and to it only.

To sum up. Use the term weight in its legal sense, which is that understood by the engineer and by people in general; define mass with reference to acceleration, and not as "quantity of matter"; understand that the passage from an absolute to a gravitation system [not from mass to weight] is by means of a suitable factor with a corresponding change of unit, and all confusion vanishes.

The agitation in favour of an absolute system involving the "poundal" should be discouraged for the reason, among others, that the adoption of the metric system is delayed in consequence. The metric system alone is sufficient for both engineer and physicist. T. W. WRIGHT.

Schenectady, N.Y., December 17, 1896

Acceleration.

In NATURE, No. 1415, p. 125, Prof. Lodge asserts that the subject of acceleration is at the root of the perennial debate between engineers and teachers of mechanics; and he urges clearness of idea and accuracy of speech on all who deal with the junior student. Towards this end I would suggest that the too common phrase "acceleration of velocity" should be abandoned when the idea intended is "velocity of velocity." $\dot{V}$ and $\dot{\mathrm{V}}$ ought not to be confounded. Let the student be told that the time-rate of change of a particle's speed in any given *fixed* direction at a given instant is called the acceleration of the *particle* in the given direction at the given instant. If the direction of the particle's motion at the given instant makes an angle θ with the given fixed direction L, and if the speed of the particle in its own direction at this instant is V, its speed in the direction L is $V \cos \theta$. The time-rate of change of this is called the acceleration of the *particle* in the direction L. It is $[\dot{V} \cos \theta - V\dot{\theta} \sin \theta]$ units of speed per unit of time. If $\theta = 0$, L coincides with the line of motion, hence the acceleration of a particle along its line of motion is $\dot{V}$ units of speed per unit of time. If $\theta = \frac{1}{2}\pi$, L coincides with a normal, hence the acceleration of the particle along a normal is $V\dot{\theta}$, *i.e.* it is the product of the linear speed and the angular speed. Linear speed is expressed in units of length per unit of time; angular speed is expressed in units of angle per unit of time. Acceleration is expressed in units of speed per unit of time.

EDWARD GEOGHEGAN.

Bardsea.

THIS is simply kinematic, and well known; but perhaps its adduction at the present time is useful as emphasising the fact that acceleration in general is not a ludicrously simple and obvious idea. The term "velocity" is, however, hardly a good synonym for "rate of change" of everything: the term "fluxion" would be better; moreover, none of the phrases about "units" are necessary.

O. J. L.

The Rydberg-Schuster Law of Elementary Spectra.

THE interesting law of connection shown so clearly by Prof. Schuster in the recent pages of NATURE (vol. lv. p. 200, and p. 223), to exist between the primary and secondary series of lines in the representations given by Kayser and Runge of the spectra of certain metallic elements, is a law which seems so suggestive of the musical phenomena termed in acoustics "difference-tones," as a possible explanation of its origin, that it may perhaps be of some use in seeking for a true account of the connection, to show here how it may be held, if not quite perfectly and exactly, at least up to a certain point of great resemblance, to possess that aspect.

The set of fundamental and over agitation-rates comprised in a Balmer-series, form a sort of chime of rays together, perhaps not very unlike the mixture of notes composing the almost vocal-sounding scream, or buzz, rather than a pure note, which a humming-top emits. From combined actions of the proper members of this chime, sets of vibrations would no doubt arise, with oscillation-rates in a succcession of secondary series, equal to the surplus rates of all the succeeding proper members of the chime above the oscillation-rate of some starting member. In the case of Balmer's series, $n = \frac{1}{\lambda} = A\left(1 - \left(\frac{2}{m}\right)^2\right)$, the differential set for all the vibration-rates following the first, or fundamental rate, $n_1 = A\left(1 - \left(\frac{2}{3}\right)^2\right)$, is represented generally by

$$n'_1 = A\left\{\left(1 - \left(\frac{2}{m}\right)^2\right) - \left(1 - \left(\frac{2}{3}\right)^2\right)\right\} = A\left\{\left(\frac{2}{3}\right)^2 - \left(\frac{2}{m}\right)^2\right\};$$

or $n'_1 = \left(\frac{2}{3}\right)^2 A\left(1 - \left(\frac{3}{m}\right)^2\right)$, a slightly modified Balmer-series, of which the convergence frequency,

$$\left(\frac{2}{3}\right)^2 A, \text{ is } = A - A\left(1 - \left(\frac{2}{3}\right)^2\right),$$

or the excess of the primary series' convergence-frequency, A, above its fundamental rate of vibration, $A\left(1 - \left(\frac{2}{3}\right)^2\right)$; the law of dependence of the secondary on the primary series found to hold good in a number of line-spectra of the elements, by Prof. Schuster and Prof. Rydberg. But the form of the second series is a little different from that of the first, in that the coefficient of its second term is nine times instead of four times the fixed value of the first term. I regret that I am not familiar enough with the measurements obtained, and with the very important discussions that have been based upon them, to be able to say if any secondary series of this modified form, or of the similar higher forms, as $n'_2 = \left(\frac{1}{2}\right)^2 A\left(1 - \left(\frac{4}{m}\right)^2\right)$, &c., are met with in the ranks of lines found by Kayser and Runge to accompany the chief, or leading ranks in so many of the spectra of the elements. But as a supposition which seems thus to present itself most prominently and invitingly for trial and consideration, I would yet venture to suggest that real or actual productions of secondary rays by differences of rates of vibration among primary rays, may perhaps occur in molecules in some such way as that recently expounded by Prof. Everett[1] to account for the corresponding phenomenon of audition of difference-tones in acoustics without excluding those tones as purely subjective existences from a real place in physics. If the possibility of such secondary, differential light rays' origination from primary vibrations in molecules is admissible, then this present description of their long secondary, tertiary and other higher ranks or scales of vibration-rates, may perhaps prove a means (with some transformations very possibly not quite inexplicable, in the least complicated cases) of comprising all the secondary ranks' array of vibration-frequencies, and the surprisingly exact law of numerical dependence shown so very certainly and clearly by Prof. Schuster to hold between the primary and secondary ranks' terminal oscillation-rates, in one view of physical relationship together.

A. S. HERSCHEL.

Observatory House, Slough, January 9.

P.S.—The answer to this suggestion is, I see, supplied already by Prof. Schuster in his first letter on this newly-found relationship; for he has there noted (this vol., p. 201), that the above supposed successive differences, although their series, $A'\left(1 - \left(\frac{3}{m}\right)^2\right)$, is of the type $A - \frac{B}{m^2}$, only approach to, without exactly reproducing the set of frequencies of the subordinate spectrum-series. If $A - \frac{B}{3^2}$ represents the lowest or "fundamental" rate of vibration, F, in all the primary line-series, and therefore $\frac{B}{3^2} = A - F$ the "convergence frequency," A′, common, by the observed law, to both the line-series subordinate to such a primary one, then whatever values, near 4, B may have been found to have in the chief series, the first of the above ideal series of differences may easily be seen to be always $A'\left(1 - \left(\frac{3}{m}\right)^2\right)$; and this does not correspond more than approximately, except in rays of frequencies very near to the "convergence-value."

Sailing Flight.

ALL students of aerodynamics must be sorry to learn of the death of Herr Lilienthal, on August 11 last. His loss is serious, as he evidently had the courage necessary to put these exceptionally dangerous experiments to practical test, which few care to do, and had thereby gained a large experience.

I have just secured a Cyrus (*Grus antigoni*), 5 feet 2 inches in height. It weighs 16 pounds, and has a spread of wings 8 feet 8 inches.

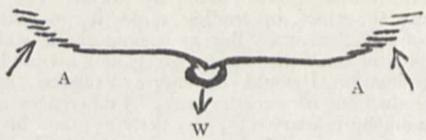
The primary feathers require 10 ounces each to bend them to the curve seen when the bird is soaring; they are 17 inches long on the feathered portion, not all identical in size or strength, but their total comes so nearly to the weight of the bird, that it is obvious the primary feathers constitute the lifting mechanism.

From the almost universal arrangement of the mode of support in relation to the weight, as seen amongst birds, bats, and

[1] *Proceedings* of the Physical Society of London, vol. xiv. p. 93; and *Philosophical Magazine*, March 1896.

fish, &c., I cannot help thinking that Lilienthal's central and superposed aeroplanes were a mistake; and that instead of that type, while the weight must be central, the sustaining aeroplanes should, like the birds, have great lateral extension.

You will observe in the diagram that the wing planes can each be divided into two portions, having quite distinct functions. The outer extremities are the sustaining aeroplanes, marked by the arrows, while the inner portion of each wing, A to W, is that which assists the bird when it is alighting, by offering a fixed passive resistance to a fall when the speed is slackened down. W is the central weight.



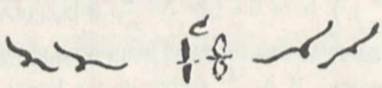
Observe also that in the bird, the sustaining mechanism is so far structurally subdivided that the loss of a primary feather is not fatal to flight; each primary lies, and acts, in a distinct plane, and has its attachment distinct from the others.

Now, it seems to me that Mr. Maxim's central aeroplane and twin screws, situated so far apart, are hardly a safe plan, for if accident happen to one screw, the other must at once stop, and the whole thing, *nolens volens*, come down.

It is not like the twin-screw steamer, where the water sustains the hull, and progress by one screw is still possible. In the aerial ship translation is the support, and it only.

In the bird, when sailing, we see no screw at work; the aeroplanes are there plain enough, lifting the 16-pound bird higher and higher as we watch it; but propeller there is none.

This propulsion, as I before stated, must be got from an outside source. The bird can only soar *in a wind*, and then, to rise, must go in spirals, passing to leeward a little at each lap. Of course the wing planes are not horizontal, but inclined thus in



passing round the centre of spiral C; and there is necessarily great centripetal reaction at such a high speed of translation as fifty or sixty miles per hour.

I think Mr. Maxim will find the bird arrangement of aeroplanes to weight, and a central screw, the best and safest. If a large central overhead aeroplane is needed, it would be for safety in alighting only.

S. E. PEAL.

Sibsagar, Asam, December 13, 1896.

OSMOTIC PRESSURE.

IN last week's NATURE, Lord Rayleigh gave, *for an involatile liquid*, a rigorous and clear proof of "the Central Theorem" of osmotics. But this theorem, though highly interesting in itself, is not, so far as I can see, useful as a guide for experiment. Consider for example the typical cases of sugar, and of common salt, dissolved in water.

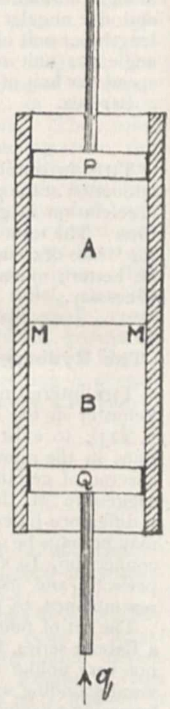
If water were absolutely non-volatile, the osmotic pressure of each solution against an ideal semi-permeable membrane separating it from pure water, would, according to the theorem, be equal to the calculable pressure of the ideal gas of the dissolved substance supposed alone in the space occupied by the solution. *This would be true whatever be the molecular grouping of the sugar or of the salt in the solution.* It is believed that experiment has verified the theorem, extended to volatile solvents, as approximately true for sugar and several other substances of organic origin, and of highly complex atomic structure; but has proved it to vastly under-estimate the osmotic pressure for common salt and many other substances of similarly simple composition.

KELVIN.

Belfast, January 19.

ON OSMOTIC PRESSURE AGAINST AN IDEAL SEMI-PERMEABLE MEMBRANE.[1]

To approach the subject of osmotic pressure against an ideal impermeable membrane by the easiest way, consider first a vessel filled with any particular fluid divided into two parts, A and B, by an ideal surface, MM. Let a certain number of individual molecules of the fluid in A, any one of which we shall call D (the dissolved substance), be endowed with the property that they cannot cross the surface MM (the semi-permeable membrane); but let them continue to be in other respects exactly similar to every other molecule of the fluid in A, and to all the molecules of the fluid in B, any one of which we shall call S (the solvent), each of which can freely cross the membrane. Suppose now the containing vessel and the dividing membrane all perfectly rigid.[2] Let the apparatus be left to itself for so long time that no further change is perceptible in the progress towards final equilibrium of temperature and pressure. The pressures in A and B will be exactly the same as they would be with the same densities of the fluid if MM were perfectly impermeable, and all the molecules of the fluid were homogeneous in all qualities; and MM will be pressed on one side only, the side next A, with a force equal to the excess of the pressure in A above the pressure in B, and due solely to the impacts of D molecules striking it and rebounding from it.



If now, for a moment, we suppose the fluid to be "perfect gas," we should find the pressure on MM to be equal to that which would be produced by the D molecules if they were alone in the space A; and this is, in fact, very approximately what the osmotic pressure would be with two ordinary gases at moderate pressures, one of which is confined to the space A by a membrane freely permeable by the other. On this supposition the number of the S molecules per unit bulk would be the same on the two sides of the membrane. And if, for example, there are 1000 S molecules to one D molecule in the space A, the pressure on the piston P would be 1001 times the osmotic pressure, and on Q 1000 times the osmotic pressure. But if the fluid be "liquid" on both sides of the membrane, we may annul the pressure on Q and reduce the pressure on P to equality with the osmotic pressure, by placing the apparatus under the receiver of an air-pump, or by pulling Q outwards with a force equal and opposite to the atmospheric pressure on it. When we do this, the annulment of the integral pressure of the liquid on the piston Q is effected through balancing by attraction, of pressure due

1 Communicated to the Royal Society of Edinburgh, January 18, by Lord Kelvin.

2 In the drawing, the vessel is represented by a cylinder closed at each end by a piston to facilitate the consideration of what will happen if, instead of supposing it rigid, any arbitrary condition as to the pressures on the two sides of the membrane be imposed.

to impacts, between the molecules of the liquid S and the molecules of the solid piston Q. We are left absolutely without theoretical guide as to the resultant force due to the impacts of S molecules and D molecules striking the other piston, P, and rebounding from it, and their attractions upon its molecules; and as to the numbers per unit volume of the S molecules on the two sides of MM, except that they are not generally equal.

No molecular theory can, for sugar or common salt or alcohol, dissolved in water, tell us what is the true osmotic pressure against a membrane permeable to water only, without taking into account laws quite unknown to us at present regarding the three sets of mutual attractions or repulsions: (1) between the molecules of the dissolved substance; (2) between the molecules of water; (3) between the molecules of the dissolved substance and the molecules of water. Hence the well-known statement, applying to solutions, Avogadro's law for gases, has manifestly no theoretical foundation at present; even though for some solutions other than mineral salts dissolved in water, it may be found somewhat approximately true, while for mineral salts dissolved in water it is wildly far from the truth. The subject is full of interest, which is increased, not diminished, by eliminating from it fallacious theoretical views. Careful consideration of how much we can really learn with certainty from theory (of which one example is the relation between osmotic pressure and vapour pressure at any one temperature) is exceedingly valuable in guiding and assisting experimental efforts for the increase of knowledge. All chemists and physicists who occupy themselves with the "theory of solutions," may well take to heart warnings, and leading views, and principles, admirably put before them by Fitzgerald in his Helmholtz Memorial Lecture (*Transactions* of the Chemical Society, 1896) of January 1896 (pages 898-909).

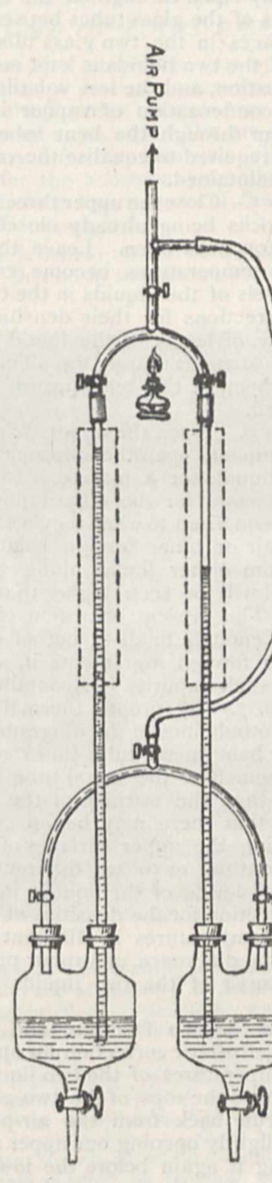
KELVIN.

METHOD FOR MEASURING VAPOUR PRESSURES OF LIQUIDS.[1]

Apparatus for realising the proposed method is represented in the accompanying diagram. Two Woolff's bottles, each having a vertical glass tube fitted air-tight into one of its necks, contain the liquids the difference of whose vapour pressures is to be measured. Second necks of the two bottles are connected by a bent metal pipe, with a vertical branch for connection with an air pump, provided with three stopcocks, as indicated in the diagram. Each bottle has a third neck, projecting downwards through its bottom, stopped by a glass stopcock which can be opened for the purpose of introducing or withdrawing liquid. The upper ends of the glass tubes are also connected by short india-rubber junctions with a bent metal pipe carrying a vertical branch for connection with an air-pump. This vertical branch is provided with a metal stopcock.

To introduce the liquids, bring open vessels containing them into such positions below the bottles that the necks project downwards into them. Close the glass stopcocks of these lower necks, open all the other six stopcocks, and produce a slight exhaustion by a few strokes of the air-pump. Then, opening the glass stopcocks very slightly, allow the desired quantities of the liquids to enter, and close them again. They will not be opened again unless there is occasion to remove the whole or some part of the liquid from either bottle; and, unless explicitly mentioned, will not be included among the stopcocks referred to in what follows. It will generally be convenient to make the quantities of the two liquids introduced such, that they stand at as nearly as may be the same levels in the two bottles, as indicated in the drawing.

Operation No. 1.—Close the stopcock on the lower passage from the bottles to the air-pump (which, for brevity, we shall call the lower air-pump stopcock); and, with the other five stopcocks all open, work the air-pump till the liquid in one of the glass tubes rises to within a centimetre of the india-rubber collar round its top.



Operation No. 2.—Open the lower air-pump stopcock till the liquids fall down the tube, nearly down to hydrostatic equilibriums in the bottles. Close it again, and work the air-pump till the liquid in one of the glass tubes rises to within a centimetre of the india-rubber collar.

Operation No. 3.—Repeat operation No. 2 over and over again until you cannot, however long you go on pumping, get the liquid in either tube to rise within a centimetre of the india-rubber collar.

Operation No. 4.—Continue Operation No. 3 until the

[1] "On a Differential Method for Measuring Differences of Vapour Pressures of Liquids at One Temperature and at Different Temperatures." (Communicated to the Royal Society of Edinburgh, January 18.) By Lord Kelvin, G.C.V.O.I.

liquid that rises higher than the other stands steadily at a convenient marked point, when the air-pump is kept vigorously going, with the lower air-pump stopcock closed. This marked point may be perhaps a few centimetres below the india-rubber collar, so as to allow the liquid surface of it to be conveniently seen through a wide glass cylinder containing hot or cold water around it, applied to fulfil the thermal conditions referred to in Operation No. 6. In these present circumstances the vapour pressure is practically equal throughout the upper bent tube, and the portions of the glass tubes between its ends and the liquid surfaces in the two glass tubes. Hence the more volatile of the two liquids is kept cool at its surface by rapid evaporation, and the less volatile liquid is kept warm by rapid condensation of vapour into it, so that, by flow of vapour through the bent tube, the difference of temperatures required to equalise the vapour pressures is very nearly maintained.

Operation No 5.—Close the upper three stopcocks, both air-pump stopcocks being already closed, and the two lowest metal stopcocks open. Leave the apparatus to itself until the temperatures become equalised. The difference of levels of the liquids in the two glass tubes, with proper corrections for their densities and for the difference, if any, of levels of the liquid surfaces in the two bottles, measures accurately the difference of vapour pressure over them, at the temperature to which they become equalised.

Operation No. 6.—Open the upper air-pump stopcock, work the air-pump and open the stopcock over the top of one of the two liquids for a minute or two and close it again. Do the same for the other liquid. Allow temperatures to be equalised to what they were at the end of Op. 5. If any air or other foreign volatile substance[1] has escaped from either liquid along with its proper vapour, its level will be seen higher than it was at the end of Op. 5. The present operation (No. 6) must be continued long enough to distil out of either, or both liquids, any such foreign ingredients if, when originally introduced, any such impurity was contained.

Operation No. 7.—By proper thermal appliances, indicated by the dotted lines in the diagram, and the lamp under the upper bent metal tube (inserted merely as an indication that somehow the metal tube is to be always slightly warmer than the warmer of the two liquid surfaces, in order that there may be no condensation of vapour in it), bring the upper surfaces of the liquids to any other temperature, or to two different temperatures. The difference of levels of the liquids in the two tubes, with proper correction for the densities of the two liquids at their actual temperatures in different parts of their columns, gives the difference of vapour pressures for the actual temperatures of the two liquids at their upper surfaces.

Operation No. 8.—To facilitate and approximately determine the hydrostatic correction for specific gravities at the actual temperatures of the two liquids, open wide the stopcocks above the tops of the two glass tubes, and let a little air run back from the air-pump, by very cautiously and slightly opening our upper air-pump stopcock, and closing it again before the lower of the two liquid surfaces reaches the lower end of its glass tube. After that, by cautiously opening and closing our lower air-pump stopcock, let in a little air to the bottles until the mean level of the liquids in the two columns rises to nearly the same level as it had in the measured positions of Op. 5 or Op. 6. In the present circumstances, air in the upper bent metal tube resists diffusion of vapour through it sufficiently to prevent any important difference of temperatures from being produced by evaporation and condensation at the two liquid surfaces, and there is practically perfect hydrostatic equilibrium of equal liquid pressures at the tops of the two columns.

The vapour pressure of water is accurately known through a very wide range of temperature from Regnault's experiments; hence, if pure water be taken for one of our two liquids, the mode of experiment described above determines the vapour pressure of the other liquid.

The apparatus may be kept day after day with the same liquids in it (all the stopcocks to be closed, except when it is not in use for observations); and thus, the observations for difference of vapour pressures may be repeated day after day; or a long series of observations may very easily be made to determine vapour pressures at different temperatures. Always before commencing observations, Operation 6 must be repeated to remove air or other impurity, if any air has leaked in, or if air or other foreign volatile impurity has escaped from dissolution in either liquid into the vapour space above it. KELVIN.

[1] See Ostwald, "Physico-Chemical Measurements," translated by Walker (Macmillian, 1892), last paragraph, page 112.

RELATIVE TEMPERATURES IN GEISSLER TUBES.

IN the Physical Institute of the Berlin University, Mr. R. W. Wood has been making a series of experiments, most interesting to students of astrophysics, with the object of investigating the relative temperatures at different parts of the discharge in a Geissler tube, with special reference to the stratification phenomena. Wiedemann and Hittorf, and also the theoretical calculations of Warburg, have shown that the temperature of the gas in the positive part of the discharge lies far below red heat, while that of the negative light, according to Hittorf, is at least below the melting-point of platinum. These observations are for the most part corroborated by the experiments of Mr. Wood, who has investigated in this case a fixed part of the discharge in an atmosphere of nitrogen under varying pressures and currents of different strengths. The results obtained by employing hydrogen instead of nitrogen established the fact that, under similar conditions of pressure and strength of current, the heating was only about 11 per cent. of that found in the former case. It was found difficult, however, to keep a steady current with this gas.

Perhaps more interesting are the results which he has been able to procure by determining the relative temperatures of the different parts of the space between the anode and kathode. For this he has designed a neat and very simple means, by which the positions of the bolometer inside the vacuum tube might be varied at will without impairing in the least degree the vacuum. The description of this apparatus will be found in the article in which the results of his observations have been published (*Physical Review*, November–December 1896, xxi.). We may, however, mention that the bolometer wire—that is, the wire which was placed in the different positions between the two poles of the Geissler tube to indicate the varying temperatures of the different parts of the discharge—was here composed of platino-iridium, and bent in the form of a loop. Its exact position could at any moment be read off from a vertical scale. It was thus found possible to make a complete map of the temperature changes inside the vacuum tube.

In the *unstratified* anode light the temperature was sometimes constant for the greater part of the column, rising to a maximum near the middle, and falling off as the dark space was approached. The maximum was always found when the light was on the point of stratifying, and sometimes at higher pressures. The exact conditions, however, could not be determined; but the extent of the anode light played an important part.

On nearing the dark space, a decrease of temperature was always observed. The temperature was found to drop very suddenly on leaving the anode light, reaching a minimum near the middle of the dark space; a rapid rise to maximum occurred as the blue negative light was entered. With a pressure sufficiently reduced to cause the appearance of *stratifications* in the anode light, the maximum was always to be found in the middle of the column, the temperature rising as the anode was left behind, and falling after the middle of the column was passed. In addition, "there is a periodic rise and fall, the light discs being warmer than the dark spaces between them, although one often finds a point where there is no change of temperature on passing from a light space to a dark." This last-mentioned fact is explained on the ground that the increase in the steepness of the curve as the maximum is approached, masks the comparatively small decrease due to the passage from the light to the dark interspaces.

One of the many diagrams he reproduces, shows the temperature fluctuations in the stratified discharge at a low pressure of 0·1 mm. The ordinates increase for a rise in temperature, and the abscissæ are longer the further the bolometer wire is away from the anode. The horizon of the diagram is taken as the temperature of the room, which in this case was 25°. Comparing the curve giving the fluctuations of the bolometer wire placed at points of different intensities throughout the tube (the latter being drawn parallel to the abscissæ), many points of interest may be at once seen. Commencing at the anode, the curve on the whole is fairly horizontal, but rises wave fashion at every increase of luminosity in the tube, dropping more or less suddenly as a dark space is entered. As the kathode is approached, the bolometer wire enters the large dark space; the curve falls somewhat abruptly down for some distance, rising again rapidly as the kathode is approached.

It may be stated that the maximum in the anode light is less predominant here than it is at higher pressures, owing to the smaller changes of temperature.

The periodic change in the stratified anode light was made the subject of a detailed investigation, more points of reference being taken. These results were also plotted in the diagram just mentioned (larger scale). "The temperature is steady for a certain distance, then rises gradually to a maximum, situated in the brightest part of the disc, turns and drops suddenly as we pass out of the sharply defined edge of the disc. The difference of temperature between the light and dark spaces varies from 0°·5 to about 1°·5, depending on the degree of exhaustion and current strength."

Assuming the electrical energy is wholly connected with heat, the temperature curves indicate for

Positive light	... Medium potential fall	.. Medium temperature
Dark space	... Small ,, ,,	... Low ,,
Negative light	... Large ,, ,,	... High ,,

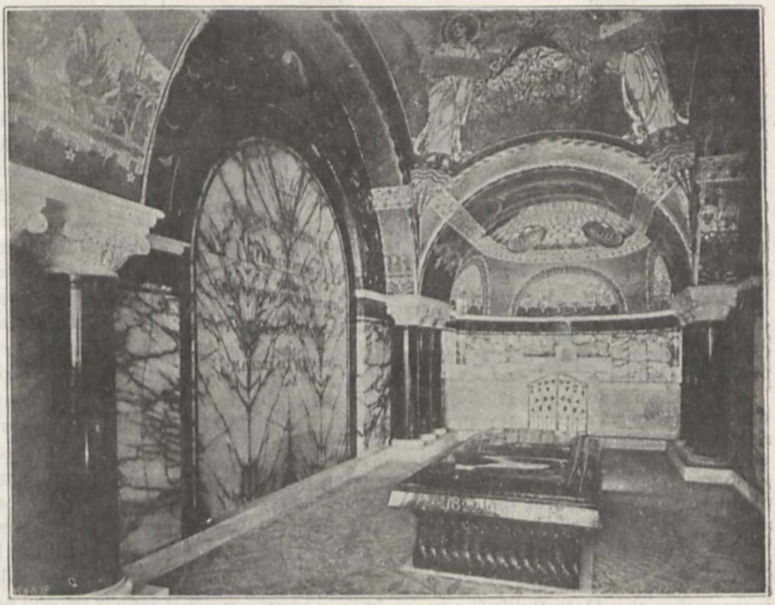
a result which, as Mr. Wood says, agrees with what is already known.

Two incidental points of interest mentioned refer to the behaviour of the strata. The movement of the bolometer loop from one stratum to another appears, at some pressures, to draw the stratum through which it is passing into the one immediately below it, the two dissolving into one, and the place left thus vacant being filled up by a new stratum springing off the anode. The edges of these strata further act as if they "had an elastic skin or a sort of surface tension, bending in as the wire pushes against them, and finally snapping back to their original positions, leaving the wire well within the luminous disc." Mr. Wood, commenting on the results, considers that the curves obtained with the movable bolometer indicate with considerable accuracy the relative temperatures in the different parts of the discharge.

THE TOMB OF LOUIS PASTEUR.

An account of the impressive ceremony with which the remains of Pasteur were laid in their last resting-place at the Pasteur Institute was given in these columns on December 31, 1896. We are indebted to the *Lancet* of January 9 for the following full description of the tomb, and for the accompanying illustration, which is reproduced from a fine picture of the mausoleum of the great French investigator.

The mausoleum is built at the end of a long corridor in the Institute, and is shut off by magnificent gates of wrought iron.



Before describing it, it is interesting to note that it was built by the Pasteur family, and Monsieur J. B. Pasteur, the son of the great *savant*, suggested as a model the well-known tomb of Galla Placidia at Ravenna, which he had visited in the course of his travels in Italy.

This tomb was built about 440 by the Christian Empress Placidia, the daughter of Thedosius the Great. It is in the form of a Latin cross 49 feet long and 41 feet broad, and we may refer to it in some detail to show how it inspired the architect of Pasteur's tomb, Monsieur Girault. The interior of Placidia's tomb is covered by mosaics, on a blue ground. Above the entrance are garlands of fruit and foliage; and in the dome the symbols of the Evangelists. In the four arches which support the dome are figures of eight apostles, and between them is seen the familiar representation in mosaics of doves drinking out of a vase. Under the vaulting of the right and left transept are the other apostles, and, between them, stags drinking at a spring in the midst of golden foliage. There are also designs in mosaic of branches of vines; and two subjects, full of grace and dignity, the *chef-d'œuvres* of Christian art in the fifth century, the first representing the Good Shepherd with His sheep, and the second representing the triumph of the Christian faith. The altar is constructed of oriental onyx, and behind it is the large marble sarcophagus, which was at one time enriched with plates of silver.

Turning now to the Pasteur mausoleum, we find the archway over the gates decorated in mosaic with irises on a gold ground, and there is also the simple inscription—"*Ici repose Pasteur*," and on either side of it the dates of his birth and death—1822–1895. Passing through the gates, the crypt is approached by a flight of nine steps of white statuary marble. The pavement of the crypt is of marble mosaic, on which are represented large wreaths of laurel. The crypt is formed by four arches which support a cupola, and in the centre is placed the sarcophagus, which is carved out of a single block of dark-green porphyry. The arches are supported on four groups each of three columns, two of green porphyry and one of red, with Byzantine capitals of white marble. The walls of the crypt are lined with pavonazza, a cream-coloured marble richly veined in black, and above it are beautifully executed mosaics. On the marble which fills the arches on the right and left are inscriptions indicating Pasteur's discoveries in historical order as follows:—

1848. Dyssymétrie Moléculaire.	1871. Études sur la Bière.
1857. Fermentations.	1877. Maladies Virulentes.
1862. Générations dites Spontanées.	1880. Virus Vaccins.
1863. Études sur le Vin.	1885. Prophylaxie de la Rage.
1865. Maladies des Vers à soie.	

Beyond the sarcophagus is an apsidal chapel containing an altar of white marble enclosed by a balustrade of the same material. Above the staircase is the following inscription from the oration delivered at the reception of Pasteur into the Academy of Science: "Heureux celui qui porte en soi un dieu, un idéal de beauté, et qui lui obéit—idéal de l'art, idéal de la science, idéal de la patrie, idéal des vertus de l'Evangile." In the apse is another inscription containing the name of the architect and other interesting particulars: "Ce monument fut élevé en MDCCCXCVI. à la mémoire de Pasteur par la piété de sa veuve et de ses enfants. Charles Louis Girault composa l'architecture et la décoration; il dirigea les travaux. Luc Olivier Merson dessina les figures de la coupole. Auguste Guilbert Martin exécuta les mosaïques."

In the mosaics are representations of fowls, cattle, sheep, and dogs, indicating Pasteur's researches on chicken cholera and attenuation of virus, on anthrax, on *clavelée* or sheep pox, and on rabies. There are also beautiful designs of hops, vines, and mulberry trees with silkworms and moths, illustrating respectively his researches on the so-called diseases of beer and wine and on the silkworm disease. Pasteur was a devout Roman Catholic, and the religious side of his character is indicated in the mosaics by angelic figures of Faith, Hope, Charity, and Science, and, above the altar, by the figure of a dove descending, representing the Holy Spirit, and on either side the Greek letters A and Ω. At the top of the cupola, light is admitted through slabs of oriental onyx.

Such is the magnificent resting-place of Louis Pasteur, and it was a happy idea that this tomb should be placed where his successors carry on his great work, and where students from all parts of the world may be reminded of the example he set of a life of untiring devotion to science and humanity.

NOTES.

THE new Session of Parliament began on Tuesday. From the forecast of legislative business contained in the Queen's Speech, it appears that the most stringent measures are being taken for the eradication of plague at Bombay and Karachi. Against this declaration attention may very well be called to foreign complaints of English apathy in the matter. Prof. Drasche, of Vienna, member of the Supreme Sanitary Council, complains that England has not shown the least interest in adopting any code of regulations for dealing with the plague and confining it within narrow limits; and the Paris press are protesting against our carelessness and neglect of effective precautionary measures. Another item in the Queen's Speech refers to education. A measure for the promotion of primary education will be brought in; and, if time permits, further proposals for educational legislation will be considered. A Bill for the establishment of a Board of Agriculture in Ireland will also be introduced.

PROF. DR. PAUL HARZER, Director of the Observatory at Gotha, has been appointed Director of the Observatory at Kiel, and professor of astronomy in the University there, in succession to the late Prof. Krüger. The Gotha Observatory was founded at the beginning of this century, and has numbered among its directors Encke, Hansen, Krüger, Seeliger, and Becker.

THE German Emperor and Empress visited the Polytechnic Institute at Charlottenberg on Tuesday in last week, and were present at a lecture delivered by Prof. Linde on the "Liquefaction of Air." His Majesty conferred upon Prof. Linde membership of the Second Class of the Order of the Crown.

DURING the nine months which have elapsed since the last public announcement, considerable progress has been made with the work of the Huxley Memorial Committee. The full-sized model for the statue, on which Mr. Onslow Ford, R.A., is engaged, is well advanced, and will shortly be completed; and the Trustees of the British Museum of Natural History, at South Kensington, have accepted the offer of the statue itself, which will be executed in marble, and ultimately placed in the central hall of that institution, near the statue of Darwin. The design for the Royal College of Science medal has been obtained by prize competition among persons resident in Great Britain and Ireland, and the selection has fallen upon the design of Mr. L. Bowcher, who has produced a highly successful work of art, and is now engaged upon the dies. The amount promised and received is now about 2900*l.*, over 600*l.* having been subscribed since progress was last reported in the public press. Subscription has been largely promoted by local institutions and scientific societies in various parts of the world. Bristol, Leeds, Leicester, Adelaide, Sydney, New Zealand, and Calcutta have been conspicuous by their aid; British Guiana, Cairo, the East Indies, and Mauritius have contributed; and welcome support has been received from the United States of America, from France, Germany, Austria-Hungary, Holland, Belgium, and Switzerland, Scandinavia, Italy, Portugal, Russia, and Servia, from Mexico and Peru, and from Arabia and Japan. Aid is expected from other centres, both at home and abroad; and the nature of any additional memorial yet to be decided upon must largely depend upon the amount still to be subscribed. In consideration of the world-wide support which the memorial has received, it is hoped that it may be possible to secure a form of memorial in which persons of all nationalities shall participate. Donations may be sent to the Treasurer, Sir J. Lubbock, or the bankers, Messrs. Robarts, Lubbock, and Co. (15 Lombard Street, E.C.), or to the Hon. Secretary, Prof. G. B. Howes (Royal College of Science, South Kensington, S.W.).

THE New York Academy of Medicine will celebrate the jubilee of its foundation on January 29.

SIR W. MARTIN CONWAY will describe his expedition across Spitzbergen, on Monday next, January 25, at a meeting of the Royal Geographical Society.

IT is with great regret that we announce the death on Sunday morning, January 10, of Kristian Bahnson, the distinguished ethnologist, of Copenhagen. He had accomplished much, and gave promise of valuable work in the future.

THE *Times* correspondent at Teheran reports that a severe earthquake occurred at the island of Kishm, in the Persian Gulf, on January 11, causing enormous loss of life.

THE University of Catana has been presented with the Island of Cyclops, off the coast of Sicily, by Signor Gravina. The island is only a kilometre in circumference, but its configuration is peculiar, and the centre is about one hundred metres above sea-level. It is proposed to construct upon the island a laboratory for investigations in zoology and pisciculture.

THE scientific expedition organised by the German Government to study the economic and industrial conditions and possibilities in the Far East will probably start from Bremen on January 27, on board the North German Lloyd steamer *Sachsen*. The nature and scope of the investigations to be undertaken have been discussed and settled at a recent meeting at the Ministry of the Interior.

AT the twenty-fourth annual dinner of the Old Students of the Royal School of Mines, to take place on Tuesday, January 26, at 7 p.m., at the Criterion, the chairman will be Dr. T. K. Rose. Profs. Judd, Perry, Rücker, Tilden, Howes, Farmer, Roberts-Austen, and Le Neve Foster have promised to be present; and amongst other guests may be mentioned Sir G. G. Stokes, Bart., Sir Frederick Abel, Bart., Mr. Windsor Richards (President of the Institution of Mechanical Engineers), and Dr. Hicks (President of the Geological Society).

ON the 28th inst. Prof. James A. Ewing will commence, at the Society of Arts, a course of six Howard Lectures on "The Mechanical Production of Cold." The Howard Lectures were founded on a bequest by Thomas Howard, in 1872, who left a sum of money for a prize to the author of a treatise on "Motive Power or its Applications." The lectures are given at intervals, as the accumulations of the fund permit, and are afterwards published in book form. Courses have been delivered by Sir William Anderson, on "The Conversion of Heat into Useful Work," and by Prof. Unwin, on "The Development and Transmission of Power."

THE Franklin Institute of Philadelphia announces the award of the following John Scott Legacy Medals and Premiums:—William S. Burroughs, of St. Louis, for his calculating machine; Émile Berliner, of Washington, for his gramophone; Edward Brown, of Philadelphia, for improvements in pyrometers; Dr. W. C. Röntgen, for his investigation of a new kind of rays; Dr. Elisha Gray, for his telautograph; Pedro G. Salom and Henry G. Morris, of Philadelphia, for their automobile vehicle. The Elliott-Cresson Medal has been awarded to Hamilton Y. Castner, of Oldbury, for his electrolytic process for caustic and bleach.

THE International Exposition to be held at Brussels this year will comprise a Science Section divided into seven classes, viz. mathematics and astronomy, physics, chemistry, geology and geography, biology, anthropology and bibliography. Various advantages are offered to exhibitors, among them being space free of charge, and reduction of rates for the transport of the exhibits. In connection with this Exposition, the Belgium Government offers prizes, amounting in the aggregate to twenty thousand francs, for the best solutions of a number of scientific problems, a list of which can be obtained from M. Van Overloop, 17 rue de la Presse, Bruxelles. Objects and memoirs intended for competition or exhibition should be sent in before the middle of April.

WE regret to record the death of Dr. F. J. Mouat, formerly Professor of Chemistry and Materia Medica, at Calcutta, and Chemical Examiner to the Government of India. He was a Fellow of a number of British learned Societies, and member of the Senate of Calcutta University. We also have to announce the deaths of Dr. W. Deecke, of Muhlhausen, one of the foremost authorities upon ancient Etruria and the Etruscans; General Francis A. Walker, President of the Massachusetts Institute of Technology; Prof. W. H. Pancoast, President of the Medico-Chirurgical College in Philadelphia: Dr. Theodore G. Wormley, Professor of Chemistry and Toxicology in the University of Pennsylvania; Dr. F. Buka, Professor of Geometry in the Technical High School at Charlottenburg; and Dr. Josef von Gerlach, Professor of Anatomy in the University of Erlangen.

FOLLOWING the example of the Institution of Civil Engineers, the Society of Civil Engineers of France has built itself a magnificent house, which was opened with great ceremony, on January 14, by the President of the French Republic. A large number of guests were present at the soirée, including representatives of the various French technical societies. The only English society represented was the Iron and Steel Institute, who sent Prof. Roberts-Austen. The new building, which is situated in the Rue Blanche, Paris, was designed by M. F. Delmas, and was erected in 262 days. It comprises in the basement engine-rooms and store-rooms, on the ground floor the meeting-room, on the first floor reception-rooms for the members, on the second floor the secretary's offices and the council-room, and on the third floor the library. Access to the various floors is obtained by means of an electric lift. The meeting-room contains seats for 500 persons, and the floor is so arranged that it may be horizontal for receptions, or inclined so as to convert the room into an amphitheatre for the meetings. The floor weighs thirty tons, and its transformation from a horizontal to an inclined position is effected with great rapidity by means of hydraulic machinery.

IN commemoration of Jenner's discovery of the benefits of vaccination, a special meeting of the Russian National Health Society was held at St. Petersburg a few days ago, a large and distinguished company being present. A report of the meeting, and a description of the exhibition held in connection with it, appears in the current number of the *British Medical Journal*. The opening speech was made by the Grand Duke Paul, the Honorary President of the Society; and addresses in praise of Jenner and his work were delivered by Dr. Kúdrin, the acting President; Prof. Lukianoff, the Director of the Imperial (Oldenburg) Institute of Experimental Medicine; and Dr. Kormillo. The results were announced of the competition for the prizes, which, it will be remembered, the Russian National Health Society offered for the best work on vaccination. Thirty-two essays were received, in various languages. The Society's gold medal and 1000 roubles, which had been originally offered, was not awarded. A gold medal was given to Dr. Layer, of Bordeaux, for his essay in French, "À la mémoire d'Edouard Jenner"; a gold medal to Dr. Miller, the Chief Physician to the Moscow Foundling Hospital; a small gold medal to Dr. Glagolef; and silver medals to Dr. Delobel, and M. Kazet, veterinary surgeon.

A SPECIAL telegram to the *Daily Chronicle* announces that Mr. Fitzgerald and Zurbriggen, the Swiss guide, began to climb Mount Aconcagua, in the Andes, on Christmas Day. At a height of 21,000 feet, Gussfeldt's card, dated March 1883, was found in a tin box. The explorers had to descend to the valley for three days, but a second attempt was begun on December 30, and an altitude of 22,500 feet was reached on January 2. A third attempt to get to the top of Aconcagua was commenced a week later. The *arête* between the peaks, at a height of 23,000 feet, was reached on January 14. Mr. Fitzgerald then had to turn back, but Zurbriggen reached the summit, which is over 24,000 feet high. This is the greatest altitude yet attained by mountaineers. The following item of climbing history is abridged from an article in the *Chronicle*:—"The serious business began with De Saussure, and has been going on ever since. He was soon followed by Humboldt, who climbed Chimborazo (19,000 feet) in 1802. The next climber to set foot on that mountain was Mr. Whymper, in the year 1880. The Jungfrau was first ascended in 1811, and the Finsteraarhorn in 1812. The other Swiss peaks have fallen one after the other—the Wetterhorn in 1854, Monte Rosa in 1855, and the Matterhorn in 1865. Mr. Freshfield scored the first great victory when he climbed Elbruz (18,526 feet) in 1868; but long before that Gerard had climbed to 19,410 feet on Porgyul in 1818. The highest climbs of later years have been those of Sir Martin Conway, who climbed Pioneer Peak in the Himalayas in 1892, and of Mr. Mummery and Mr. Hastings, who climbed to 21,000 feet on Nanga-Parbat. Dr. Gregory reached to about 16,000 feet on Mount Kenya in Central Africa (20,000 feet high), and Hans Meyer reached to 16,830 feet on Kilima N'jaro. In Asia there are four colossal mountains which still defy all efforts. Mount Everest (29,000 feet) still lies far beyond the reach of man. Dapsang (28,700) is almost equally inaccessible. Tagarma (25,800) and Khan-Tengri (24,000) have yet to be scaled. Similarly, in Africa, the highest mountain is still a virgin; and though Mount Cook (12,349) has been climbed in New Zealand, Charles Louis (20,000) still remains unascended in New Guinea, and seems likely to remain so."

A TOUCH of real winter has been experienced over the British Islands during the last week, and the thermometer has in many places registered a lower reading than on any previous occasion since winter set in. Towards the close of last week, and especially on Friday and Saturday, snow fell very generally at many of the English stations, and on Saturday night there was a fairly heavy fall in the metropolis. The snow quickly disappeared from the more crowded parts of London, but it remained unthawed in the suburbs on Tuesday morning. The thermometer in the screen at night has registered 10° or 12° of frost in many parts of Great Britain, while the exposed thermometer, on the grass, has fallen several degrees lower. The type of weather over our Islands has become anticyclonic; and if these conditions continue, a spell of settled cold weather will be experienced.

THE two young naturalists of the University of Cambridge (Mr. J. Graham Kerr and Mr. J. S. Budgett), who left England in August last for the Chaco Boreal of Paraguay, in quest of specimens of the American Lung-fish (*Lepidosiren paradoxa*), appear to have been very successful. Letters recently received from Mr. Kerr inform us that on arriving on the Upper Paraguay they found that there had been a mission station lately established in the Chaco, near the very spot where *Lepidosiren* was said to be most abundant. On arriving there the travellers were entertained on roast *Lepidosiren* for supper the very first evening, and found that this queer fish was very common in the surrounding swamps. A large series of specimens and eggs in every stage of development has been obtained, and Messrs. Kerr and Budgett will shortly return home with their collection in order to work out the results, which promise to be of no little interest.

A REUTER correspondent at St. Petersburg reports the arrival there of two Danish officers, MM. Oloufsen and Philipsen, on their return from a journey of exploration to the Pamir country, where they reached places hitherto untrodden by Europeans. They have brought back with them over 30c photographs of places they have visited and types they have met. During their travels they met, among others, tribes who are still fire-worshippers and totally uncivilised in their mode of life. It is said that the men of these tribes and even their animals are of very small size, the bulls and cows being no larger than a European foal, the donkeys about the size of a large dog, and the sheep about as large as a small poodle. The use of money is unknown to them, and their only trade consists in the bartering of furs. Women are bought at the rate of five or six cows or fifteen sheep apiece. These natives are very timid, and on the approach of strangers take to flight. MM. Philipsen and Oloufsen have secured numerous scientific collections, which they intend presenting to the Natural History Museum in Copenhagen, and have also made interesting meteorological observations. In the course of their voyage they occasionally reached a height of 14,000 feet above the level of the sea.

THE annual meeting of the Institution of Electrical Engineers was held on Thursday last, and Sir Henry Mance, C.I.E., succeeded Dr. Hopkinson as President. The Institution has been in existence twenty-five years, and it now has three thousand members. Founded originally by electricians and telegraph men, it has adapted itself to modern requirements, with the result that it is now the oldest and largest society of electrical engineers in the world. In the course of his presidential address, Sir Henry Mance, who has been actively connected with submarine telegraphy for the best part of his life, said that the earliest record of a subaqueous line is that of the experiment made by Baron Schilling, who, in 1812, exploded mines across the river Neva, using wire insulated with india-rubber. The earliest record at Somerset House of any submarine telegraph company is dated June 16, 1846, when the late Jacob Brett and Alexander Prince obtained a renewal of their provisional certificate of registration for the General Submarine and Oceanic Telegraph Company. The first concession connected with international submarine telegraphy was also granted to Jacob Brett in 1847, so that this year we may fairly be said to have reached the jubilee of the inception of international telegraphy. Sir Henry Mance said he had come to the conclusion that to no one individual could fairly be granted the credit of the inception and development of the submarine cable; the work was the work of many.

A DETERMINATION of the velocity of a flight of ducks, obtained by triangulation, was made at the Blue Hill Meteorological Observatory on December 8, and is described in *Science* by Mr. Helm Clayton. While engaged with Mr. S. P. Fergusson in measuring clouds, a number of ducks passed across the base-line, which is 2590·3 metres (8496 feet) in length. The observers succeeded in obtaining a simultaneous set of measurements on the apex of the flock, and one or two independent subsequent observations, and from these data the height of flights, as well as the velocity, was calculated. The height was 958 feet above the lower station, which is situated in the valley of the Neponset River, above which the ducks were flying. The velocity of flight calculated from this measurement of height, and from the angular velocity measured at the ends of the base-line is 47·8 miles an hour. The wind was very light, having a velocity of only two miles an hour according to the automatic record made at Blue Hill Observatory, 615 feet above the valley station. The direction of the wind was from the north, and the ducks were flying from the north-east.

A PAPER on "The Monier System of Construction" was read by Mr. Walter Beer, at the Institution of Civil Engineers, on January 15. The system originated in the attempts of a Parisian florist, named Monier, to obtain large vessels of a material more durable than wood and lighter than concrete. The principle of the system is the combination of Portland-cement concrete with iron or steel in such a manner as to develop in the same material the high resistance, to compression and binding of the former, and the great tensile strength of the latter. It has been found that in such a combination the good qualities of both materials are retained, and no chemical action occurs between the iron and the moisture in the concrete. The latter adheres firmly to the smooth surface of the metal; and the coefficients of expansion of the two constituents are for all practical purposes identical. The economy of the system in the construction of girders and arches is considerable, owing to the great strength and compactness obtained, and, further, the material is absolutely fire-proof. Large spans may be used for floors, and the small amount of head-room required is a factor often of great value. The system can also be used in situations where brick and stone would be impossible.

IT is well known that air-currents containing either drops of water or fine dust in suspension give rise to electrification whenever they impinge on a solid obstacle. M. P. de Heen, guided by the view that electricity, independently of all luminous phenomena, can produce photographic impressions, has tried the experiment of allowing a current of air, laden with *Lycopodium* powder, to fall on a sensitive plate, and the photograph thus obtained is reproduced in the *Bulletin* of the Belgian Academy. With an uncovered plate, a feeble but distinct impression was obtained after one and a half hours, but by using a covered plate a much more powerful impression was produced. The most remarkable feature is that where the covering has been broken away dark ramifications are seen extending some distance into the covered portion, and these appear to follow the directions in which electricity has been propagated along the surface of the plate. In this connection attention may well be directed to the experiments described on p. 269 of this number of NATURE.

THE relative transparency of the alkaline metals to Röntgen rays, forms the subject of a note by Prof. C. Marangoni in the December number of the *Atti dei Lincei*. The author draws the following conclusions: (1) The most transparent metal is lithium, and its transparency does not increase with the thickness; (2) the anomaly of the greater transparency of sodium relative to potassium would suggest that the transparency for these rays is a function of the atomic weight as well as of the density.

IT is satisfactory to note that local fishery authorities are becoming increasingly interested in the scientific study of sea fisheries. The Northumberland Sea Fisheries Committee carried out in the summer of 1896 a series of trawling excursions in the bays of its district for the purpose of examining their condition and their productiveness, and a report on the results, drawn up by Mr. Alex. Meek, has been published. Mr. Meek is attached to the Durham College of Science at Newcastle-on-Tyne, and the more deliberate studies of the material collected were carried on in that institution. The report contains interesting details concerning the animals captured in trawl and tow-net, the pelagic eggs, and the food of the fishes.

THE latest instalment of the "Account of the Crustacea of Norway with short descriptions and figures of all the species," which Prof. G. O. Sars is publishing, forms the commencement of vol. ii., and of the description of the Isopoda. The general remarks on the Order only occupy three pages. The classification employed is that adopted by the author in 1882, the Order being divided into six tribes according to the characters of the first pair of legs, of the last pair of appendages (uropoda), and of the five pairs in front of the last (pleopoda). The first tribe, Chelifera, is distinguished by the fact that in its members the legs of the first pair are cheliform, that is, have prehensile claws. Twenty-six species in this tribe are described, and these are figured on sixteen autograph plates.

IN the last number of the *Records* of the Geological Survey of India, there is recorded a discovery by Dr. J. W. Evans, which adds another to the long list of geological resemblances between the peninsula and South Africa, and is also of some economic importance. This is the sedimentary nature of the gold-bearing rocks of Mysore, Dr. Evans having proved that what had been regarded as a quartz vein is in reality a quartzite.

THE following are among the lectures to be delivered at the Royal Victoria Hall, Waterloo Road, during February:—February 2, Mr. H. Bernard, on "Scorpions and their Relations"; February 9, Mr. R. A. Gregory, on "Photography of the Heavens"; February 23, Dr. J. W. Waghorn, "X and other Rays of Light."

THE fiftieth annual general meeting of the Institution of Mechanical Engineers will be held on Thursday and Friday, February 4 and 5. On each occasion the chair will be taken by the President, Mr. E. Windsor Richards. The following papers will be read and discussed, as far as time permits: "Fourth Report to the Alloys Research Committee," by Prof. W. C. Roberts-Austen, C.B., F.R.S. (Thursday); "Partially Immersed Screw-Propellers for Canal Boats; and the influence of Section of Waterway," by Mr. Henry Barcroft (Friday); "Mechanical Propulsion on Canals," by Mr. Leslie S. Robinson, of London (Friday).

THE first number for the current year of the *Biologisches Centralblatt* contains the commencement of an important article, by Dr. T. Bokorny, on the organic nutrition of green plants, and its importance in nature.

NUMBER 1 of vol. xxxii. of the *Proceedings* of the American Academy of Arts and Sciences is devoted to contributions from the Gray Herbarium of Harvard University, of interest to students of the flora of the United States.

PART XVII. of Dr. R. Braithwaite's "British Moss-Flora" has just been received. It commences Section 8 of this very valuable work, and deals with the Hypnaceæ. The two remaining families of Pleurocarpous mosses will be described in future parts.

We have received the Part for December 1896 of the *Agricultural Students' Gazette*, edited by students at the Royal Agricultural College, Cirencester. It contains papers on coffee-planting in British Central Africa; on clearing and preparing forest-land for cane in Queensland; and on experiments on permanent grass on the Lydney Park Estate, Gloucestershire.

MR. STEPHEN MARRIOTT has sent us a little bo k of his, entitled "To Winnipeg, Manitoba, and Back" (Simpkin, Marshall, and Co.). Though primarily of interest to intending emigrants, it contains much information worth reading; and, in view of the visit of the British Association to Canada this year, should find readers in the scientific world.

THE additions to the Zoological Society's Gardens during the past week include two Patas Monkeys (*Cercopithecus patas*, ♂ ♀) from West Africa, presented by Mr. W. Loy; a Prairie Marmot (*Cynomys ludovicianus*) from North America, presented by Mr. W. Hewlett; two Kestrels (*Tinnunculus alaudarius*), British, presented by Miss Fanny D'Aeth; a Greater Black-backed Gull (*Larus marinus*), British, presented by Mr. W. Theobald; a Pardine Lizard (*Acanthodactylus pardus*), a Scutellated Lizard (*Acanthodactylus scutellatus*) from Biskra, Algeria, presented by Mr. H. B. Hewetson; two Indian Pythons (*Python molurus*) from India, three West African Pythons (*Python sebæ*), deposited.

OUR ASTRONOMICAL COLUMN.

COMET PERRINE 1896, DECEMBER 8.—In this column for December 31, 1896, we referred to the striking similarity between the elements of the comet discovered by Mr. Perrine on December 8, and those of the Biela comet. Dr. F. Ristenpart finds, however (*Astr. Nachr.*, No. 3396), that the resemblance between these two comets is greater than was at first supposed, the origin of the unsatisfactory large differences for the mean places having been found out. The elliptic elements, which he has now calculated, give us less reason, then, to doubt the probability of a connection between these two comets. Dr. Ristenpart compares his elements with those of comet Biela at the time of its appearance in 1852, but suggests that more observations must be used in the investigation before an accurate value of the eccentricity, and therefore of the period, can be obtained. The comparison is as follows :—

	Comet Perrine 1896.		Comet Biela 1852.
τ	Nov. 24·7433 B.M.T.		
	° ′ ″		° ′
ω	163 57 30·5	1897·0	223 17
Ω	246 24 7·2	1897·0	245 51
i	13 50 41·1	1897·0	12 33
log q	0·046412		9·9348
log e	9·843395		9·8784
a	3·676		3·526
U	7·047 years		6·62 years

DOUBLE STAR MEASURES.—Mr. R. G. Aitken communicates to the *Astr. Nachr.*, No. 3395–6, his measurements of double stars during 1895–6 with the 12-inch and 36-inch equatorial telescopes of the Lick Observatory. The majority of the measures were made with the former instrument, but occasionally the 36-inch was used for any crucial test. The selection of objects was restricted ; no special search was made for new doubles, and great care was taken to determine the proper quadrant when two stars of nearly equal magnitude were being observed. In the micrometric measurements published, Mr. Aitken gives double weight for observations made with the 36-inch ; the position angle is the mean of four or more settings, and the distance that of three double-distances.

The following are some of his remarks on interesting doubles and questionable doubles :—

OΣ 65 (Mag. 6·5, 7·0).—Certainly a physical pair, and the plane of the orbit appears to be in the line of sight. Further measures are needed at short intervals.

H VI 101 δ Tauri (Mag. 4·0, 9·0).—Distance appears to be slowly increasing.

Σ 634 (Mag. 5·0, 8+).—Rectilinear motion. Stars are moving in nearly opposite directions. Distance in 1834 was 34″, in 1896, 14·75.

H 1222.—Examined this star with the 36-inch powers to 1000. Star apparently single (1896·475). Conditions good. "Strongly suspected close double" by H. Looked for by β in 1876 without success. Probably a mistake on the part of H.

OΣ 269 (Mag. 6·5, 7·0).—Companion of this rapid binary has completed more than one revolution since the measures of OΣ. From measures down to 1891, β finds a period of 48·4 years.

Σ 2026 (Mag. 8·9, 9·0).—Undoubted binary. Angular motion should now become more rapid.

OΣ 342. 72 Ophiuchi.—With 36-inch powers 1600. Apparently single (1896·488). Powers to 2600. "No certainty of elongation" (1896·513).

Measured as a close pair by OΣ and others, but β has always found it single in the last twenty years. Probably the companion is an illusion.

β 989 x Pegasi (Mag. 5·0, 5+).—Shortest period of any known binary 11·37 years.

THE CANALS OF MARS.—We have received a communication from Herr M. Teoperberg, of the Hague, in which he submits an explanation of the formation and doubling of the canals on Mars. The idea which he suggests is one that will scarcely recommend itself to astronomers, for, indeed, *one* assumption cannot reasonably be admitted. The writer supposes a periodical downfall of snow to be the principal agent, taking the undoubted bands as the crests of anticlinals, the bases of which may be veiled from the observer by increase of absorption. Such a range, he says, presenting itself as a narrow band, will be doubled if the higher part of the crest be covered with snow. With the advance of the season the snow-covering will extend downwards on the slopes of the ridge, and its margin will at last dip into those strata which escape our observation : the bands will then be lost for a time, reappearing by the inverse process at the next change of season. As another instance of such combinations, he says, "a synclinal, filled up in winter with snow extending also, but in thinner layers, over the bordering ranges, will present a double band as soon as these more exposed ranges are laid bare by the melting of the snow in summer. They will then change into a single band when the central thicker mass of snow has melted away and replaced either by the dry valley ground or by a drowned *Thalweg*, these recalling the canals *prop. dict.*, differing, however, therefrom by a probably high situation and by the elevated ranges on the sides." Sufficient, however, has been quoted to show that the writer must assume in his hypothesis innumerable ranges of mountains, the highest peaks of which must be singularly placed to give the effect of straight lines or arcs. It is true that horizontal sections of mountains become more simplified the greater the elevation, and that gaps of considerable magnitude would escape observation, but even then the mountainous conditions on Mars would be very extraordinary. If such were the case, the "flashings" would be very much more numerous than they are, and the colour phenomena would probably be different from what observations tell us. The hypothesis of "vegetation" seems still to be the most satisfactory explanation for these curious canal-like markings, although even this cannot satisfy all the observed phenomena.

THE CLASSIFICATION OF MADREPORARIA.

AT present the classification of Madreporarian corals is admitted to be in an unsatisfactory condition. A fair standard of the opinion of the time can be obtained by reference to Prof. Nicholson's "Manual of Palæontology," or to Prof. von Zittel's new "Student's Text-book of Palæontology." One of the most striking features is the insecurity which is now felt about the sub-orders of Milne Edwards and Haime, the M. Rugosa = Tetracoralla (Haeckel), and the M. Aporosa and Perforata = Hexacoralla (Haeckel). Yet the authorities just named think it best to maintain these sub-orders provisionally.

I propose here to give a short sketch of some work of mine on corals, which was entered at the Royal Society of London in July 1895. It deals with the "Microscopic and Systematic Study of Madreporaria," and covers a rather wide field :—

(1) Numerous sections of the skeleton of living corals are examined and figured, all controversial points with regard to the structure of skeletal parts are exhaustively discussed, and my own views are advanced regarding microscopic structure, and the relation of the soft parts of the polyp to the skeleton.

(2) A comparative account is given of the fossil skeleton in the various families. In this part I have been greatly aided by the results of my special work on corals of Upper Jurassic age, "Stramberger Korallen," to be published next month in the *Paläontologische Mittheilungen* (Stuttgart).

(3) The determination of the main evolutionary changes within Madreporaria.

(4) Systematic results.

General Microscopy of the Skeleton.

The basal "tabula" or "dissepiment" forming the floor of the calyx presents us with the simplest form of septal structure in Madreporarian corals. Microscopically examined, it proves to be a compact series of calcareous lamellæ, each of which is made up of minute, crystalline, needle-shaped fibres, set perpendicularly to the lamellar surface. The fibro-crystals are oriented in one and the same direction throughout the whole thickness of lamellæ, hence they behave in the same way towards light. The appearance under the microscope is that of long fibres running through the lamellæ, but crossed by a dark and light band in each lamella (Fig. 1). These bands are wavy, not straight in section, and a special group of tiny fibres is present within each "wave." *The solid dimensions of such a fibrous wave-unit or "scale"* (Fig. 2) *of the lamella agrees with those of a single ectodermal cell of the polyp.* The wave-units of the lamellar surface indicate the original cell-units, whose protoplasmic contents have been changed to crystalline fibres. Still, however, some fragments of organic matter and dirt particles usually remain, and their decomposition gives rise to the dark spots and bands which blur the crystalline deposit.

The structure just described for the calcareous floor of the coral calyx repeats itself throughout all parts of the skeletal tissues. It is the structure characteristic of the Madreporarian skeleton. The endless variety of form, which we find among the skeletal parts, is produced by corresponding varieties in the calicoblastic layers of the polyp. With this difference, that the calcareous lamella is, as it were, the "cast" of the ectodermal flesh.

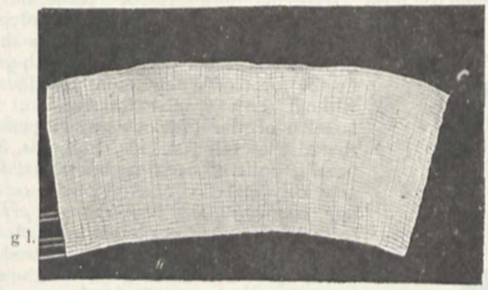


FIG. 1.—*Galaxea dissepiment: g.l.*, growth-lamellæ.

The cell-for-cell equivalence of the skeleton with the outer polypal layers explains why the fine microscopy of fossil and recent skeletons may guide the systematist in tracing the affinities between Madreporarian genera and families. I shall next consider the outstanding varieties of form which I recognise in the septa of typical Madreporaria.

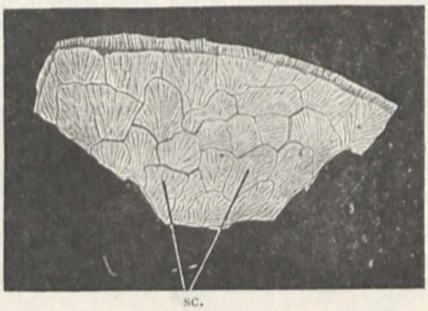


FIG. 2.—Calcareous scales on the surface of a dissepiment (from the cœnenchyme of Galaxea) highly magnified.

Septal Forms.

Bearing in mind the origin of the radial or septal fold as an invagination of the embryonic "basal plate" of the polyp, it will readily be understood that there are two opposite calicoblastic surfaces in the radial invagination instead of one surface, as in the tabula or dissepiment. Fibrous lamellæ are formed along the entire external surface of the fold. If the invagination is conical, or nearly so, naturally so is the skeletal deposit which it lays down; if smooth, the deposit is smooth. Such is the deposit of the "*septal spine*," which we see projecting inwards from the wall in many Palæozoic corals, and may still find in several species of Madrepora and other living corals. The lamellæ are formed in the septal spine around a central axis, and as the fibro-crystals are oriented rectangularly in the lamellæ, they radiate out from this axis.

Considerable notice has been taken in current literature of the central part of the spine and of its analogue in the flat septum, called the "dark line" or "primary septum." I find that the opacity of the "dark line" or "axis" is due to the same cause as the "dark bands," or closely-strewn "dark points," which occur in the fibro-crystalline deposit in the tabula, dissepiment, or any skeletal part. The organic cell-remnants are, however, massed together in the axial portion of a conical or oblong fold, and the "dark points" therefore appear more prominently in sections of septal spines and septa than in sections of a one-sided structure like the dissepiment. There is a further observation. Several of the first few layers laid down by the adjacent surfaces of a septal fold are in many cases less completely calcified than the next in age. Apparently skeletal deposit accumulates more rapidly at the septal edges than lower down on the septal sides, but the crystalline changes in the cell are less complete. While I regard the presence of disintegrating carbon products as the original cause of the "dark line," it is well known that the "line" may ultimately assume various appearances due to secondary changes (see Hinde, "On Septastræa," *Q. J. G. S.*, 1888), or may be represented by a hollow space.

If the septal invagination is long instead of round in shape, it stretches through a certain radial length in the calyx, and the calcareous deposit takes the form of a *flattish septal plate* in consequence. The lamellæ are symmetrical on either side of the "dark line," which indicates the axis or median plane of the fold. We are familiar with microscopic transverse sections of flat, plano-symmetric septa in Palæozoic Zaphrentids, as well as in our own Turbinolids. The septal spine and the plano-symmetric septum are the two most primitive forms of septal deposit, and sometimes the flat septum passes at its inner edge into spinate prolongations.

We now come to more elaborate forms. The *striated septum* (Fig. 3) develops within the flaps of a septal fold, which, instead of being smooth, is thrown into a regular system of pleats, and has a goffered edge. The surfaces of the calcareous lamellæ are consequently marked by striæ (str.) and grooves, and the striæ taper to fine serræ (sr.) at the edge of the septum. In microscopic transverse sections of striated septa, the fibro-crystals radiate out from "dark points," better called "centres of calcification," which form a row in the median plane (Fig. 4). Each "centre" represents in cross-section the long axis of a stria, or pair of striæ, according as the striæ are alternate or opposite on the two surfaces of the septum. A number of wave-units of the lamellæ are arranged around each axis, hence the unit-bunches of fibres, though minute in themselves, combine to form a relatively large, radiating bunch to which I have given the name of "*fascicle.*" It passes obliquely upwards and outwards through the series of lamellæ and gives rise to a slight eminence or "granulation" where it emerges at the surface. Striated septa occur in Stylinidæ, Oculinidæ, some Turbinolidæ, &c.; they are composed entirely of fascicles bisymmetrically arranged on either side of median axes.

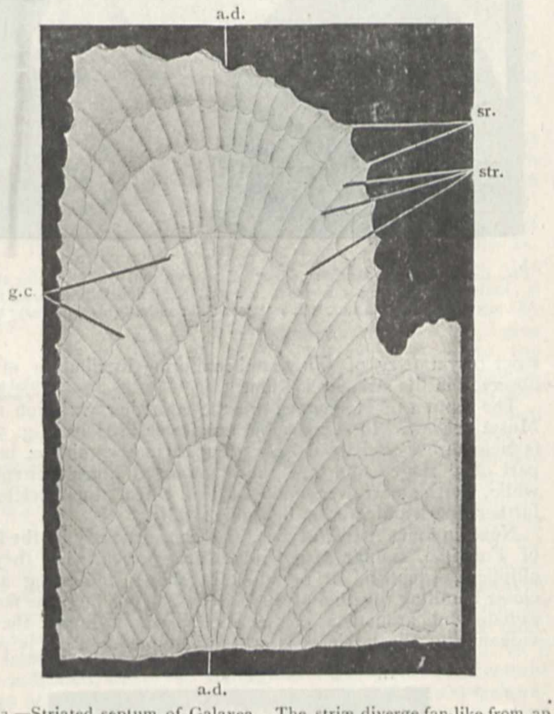


FIG. 3.—Striated septum of Galaxea. The striæ diverge fan-like from an "area of divergence" (*a.d.*); g.c. = growth-curve.

It is a further step in complication of structure to pass from the striated septum to the roughly-granulate, ridged, spiniform-toothed septum which one sees in many Astræids, *e.g.* Mussa. Each broad ridge that passes downwards from a single spiniform tooth of the edge bears on it a number of striæ, sometimes veiled superficially by the granulations, but always apparent after polishing the surface. This simply means that the septal fold in Mussa is thrown into a few very wide, deep pleats, corresponding with the broad ridges of the septal surface, and then that each wide pleat falls into a system of smaller, pitted pleats. Transverse and longitudinal sections show a departure from the strict bisymmetry of fibres and uniform distribution of axes observed in the striated septum.

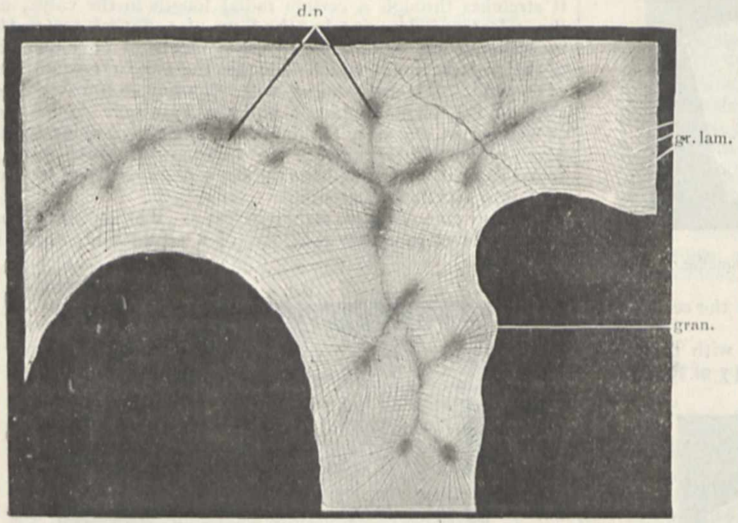
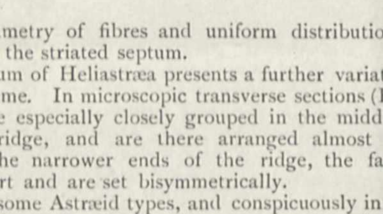


FIG. 4.—Transverse section of part of septum and wall, showing the radiating lines of structure passing out from the "dark points," and also the wavy cross-lines corresponding to successive "growth-lamellæ" (high power); gran. = granulation.

The septum of Heliastræa presents a further variation of the Mussa scheme. In microscopic transverse sections (Fig. 5), the fascicles are especially closely grouped in the middle, bulging part of a ridge, and are there arranged almost circularly; while, at the narrower ends of the ridge, the fascicles are further apart and are set bisymmetrically.

Next, in some Astræid types, and conspicuously in the family of Fungidæ, similar large ridges are present, but they are elliptical, squarish, or roundish in shape, indicating a still closer bundling together of the fascicles. As a fact, the fascicles radiate out around a common ridge-axis, although the individuality of the fascicles is still maintained. This is proved by the distinctness of emergent ends of fascicles in the thinner septa, and also by the inherent structure of parallel-set striæ. In thick septa, however, the emergent ends of fascicles coalesce to form the characteristic large granulations. These are the granulations, composite in structure, which give rise to "pseudo-synapticulæ" (Pratz), inasmuch as their large size enables those at the same horizon on adjacent septal surfaces to coalesce across the interseptal loculus.



IG. 5.—Thick central portion of a septal ridge of Heliastræa formed by a radio-symmetric trabecula (*Tr.*): and the thinner lateral wings of the same ridge passing into corresponding furrows—only bi-symmetric trabeculæ (*tr.*) are present in these (magnified 70 times).

Thus I have passed from a bisymmetric to a radio-symmetric arrangement of fascicles in septa. Throughout all these septal types, certain definite laws of growth can be observed. Each row of fascicles (Fig. 6) added along the growing septal edge, indicates a single period of growth in the existence of the polyp. I have, therefore, applied the term of "*growth-segment*" to signify one such addition made to the height of the septum; the term "trabecular part" to a pair or group of fascicles; and I define the term "trabecula" as a series of "trabecular parts" laid down during successive growth-periods of the polyp.

In the case of most Turbinolids the *basal* deposit laid down during a growth-period is in the form of a few more lamellæ added, without any spacial interruption, to the lamellæ of the previous growth-period. In the case of tall Astræids, Stylinids, &c., the basal deposit of each growth-period forms a new calycinal floor. And *the space between any one calycinal floor and its predecessor corresponds to one growth-segment of the septum.* This is a most important relation, and is one which I find also holds good for the synapticulate form of base. The "true synapticula" in Fungia and its allies would thus be homologous with a basal dissepiment, and is probably an acquired feature in them, modified from a more primitive dissepimental base. Certainly one finds that dissepiments dwindle or even disappear in these synapticulate types. The question arises of the possible advantage to the polyp of the synapticular in place of the dissepimental floor. The advantage is, at least, two-fold: (1) mechanical, as a support equally strong, although proportionally lighter; (2) physiological, as a means of extending the internal cœlenteric space by the canalicular elongations, which are supported between synapticulæ.

The septum of the Eupsammidæ is, as in the Fungidæ, frequently porous, and the interseptal loculi are bridged by the coalescence of septal ends, by pseudosynapticulæ, or by true synapticulæ. The pores of the Eupsammid septum, however, may occur not only between the adjacent "trabecular parts"

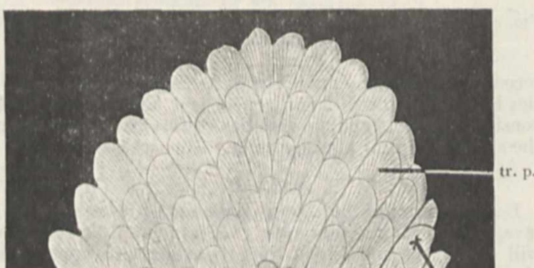


FIG. 6.—Radial structure composed of a "septal" wing and a "costal" wing. The trabeculæ diverge right and left from an "*area of divergence*" between the two wings. The single trabecula marked "*tr.*" is composed of seven trabecular parts (*tr.p.*) representing seven successive growth-periods. The trabecular parts between any two growth-curves (*g.c.*) form a "septal growth-segment," and represent one growth-period (diagrammatic).

of a growth-segment, but also between the successive "trabecular parts" in any one trabecula. Hence it is possible for a "trabecular part" to be absolutely free from its neighbours n the same radial line—to be, in short, a *free septal spine set in the calyx*, as in the case of Palæozoic Cystiphyllids. The Triassic genera Stylophyllum and Stylophyllopsis show this same feature, also several Jurassic genera, *e.g.* Epistreptophyllum and Dermosmilia, and there is no doubt that we have here an important structural feature in a living coral family which can be traced back to a feature characteristic of certain Palæozoic genera.

The Eupsammids were associated by Edwards and Haime with the Madreporidæ (sub-ord. M. Perforata). But the septal structure is very different. My sections prove that Turbinaria and Madrepora possess *compact septa* of a strictly bisymmetric type like those of Turbinolids, Oculinids, Stylinids. Porites again, the type of the other "Perforate" family of Edwards and Haime, has a porous septum composed of radio-symmetric trabeculæ. The crystalline structure of the trabeculæ in the Poritidæ distinguishes them essentially from the Fungidæ. The homology of the so-called synapticula is also in my estimation different in Porites. I regard it as having the character of an *inter*-trabecular, *inter*septal spine. It does not replace dissepimental deposit, and appears to be an *inherited feature*, not an acquired modification.

Reasoning now upon the foundation of the micro-structure of septa, I would draw the following conclusions respecting the classificatory system of Madreporaria.

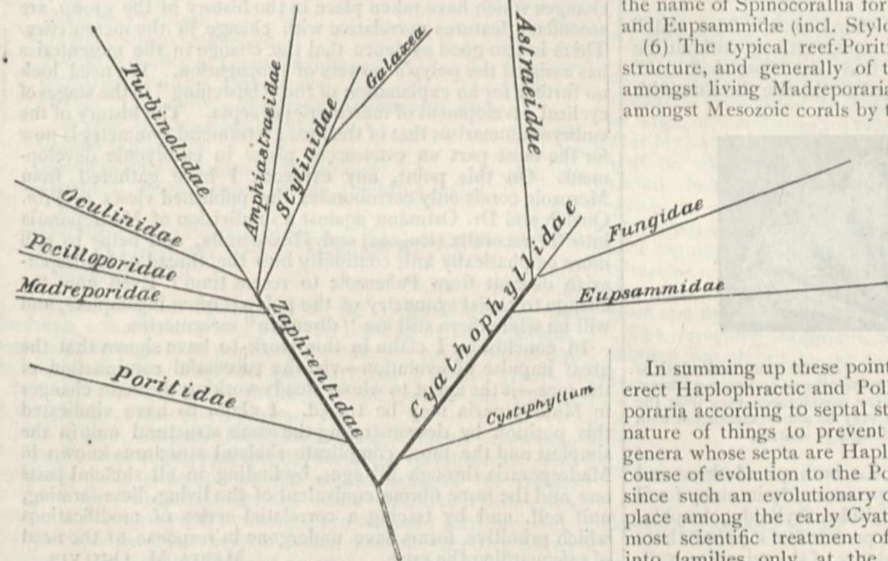


FIG. 7.—Phylogenetic diagram of Madreporaria.

(1) Septal structure affords a strong reason in favour of the abolition of the sub-orders Tetracoralla and Hexacoralla, since all the known septal types amongst Tetracoralla are also prevalent in Hexacoralla.

(2) Septal structure also disannuls the groups of M. Aporosa and M. Perforata. Madrepora and Turbinaria, typical genera of the group of M. Perforata, possess compact septa, whose structure is the same as the septa of certain typical genera belonging to the M. Aporosa. Again, similarity of septal structure characterises compact-septate and poro-septate types of Fungidæ; while one and the same specimen may have some of its septa compact, others porous.

(3) The two sub-families, Astræinæ and Eusmilinæ, hitherto recognised in the family of Astræidæ, have quite different types of septal structure. I would remove the genera of the Eusmilinæ to various other families, *e.g.* Euphyllia and allied genera to the Turbinolidæ; Amphiastræa and allied genera to a new family of Amphiastræidæ; Stylina, Galaxea, &c., to a family Stylinidæ.

(4) The fundamental similarity in the septal type of the families, Madreporidæ (excl. Eupsamminæ, E. H.), Pocilloporidæ (among which I would include Stylophora and its allies), Oculinidæ, Stylinidæ, Amphiastræidæ, Turbinolidæ, and the Zaphrentidæ among Palæozoic corals indicates a probable common ancestral line. The septal type is very simple, and shows bisymmetry of design. I give it the name of *Haplophractic*. Other considerations concerning the relations of septum and wall, and the general habit of growth, indicate a closer affinity of the colony-building families, Madreporidæ, Pocilloporidæ, Oculinidæ, Stylinidæ; they form a natural group which I call *Cœnenchymata*. While the remaining three families with the Haplophrastic septal type are characterised by a strong wall, retaining in part or wholly its primitive character as the inner lining of the epitheca. They may be termed *Murocorallia*.

(5) The fundamental similarity in the septal type of the Astræidæ, Fungidæ, and the typical Cyathophyllidæ, the Eupsammidæ, and Cystiphyllidæ, indicates an ancestral relationship of these families with one another. Their septal type is characterised by complications due to the many pleatings of the septal invagination. I call it *Pol aplophractic*, in contradistinction to *Haplophractic*, and it will be remembered that the radio-symmetric trabecula attains here its full perfection, and that the septa are frequently porous. The families Cyathophyllidæ, Astræidæ (excl Eusmilinæ), Fungidæ, are characterised by the pre-eminence of the *septum* and septo-costa in the calyx, and the regularity in the trabecular structure. They may be allied, therefore, under the name of Septocorallia. On the other hand, the irregularity of the trabeculæ, and the occurrence of the detached septal spine in the radial structure, make me choose the name of Spinocorallia for the allied families of Cystiphyllidæ and Eupsammidæ (incl. Stylophyllinæ).

(6) The typical reef-Poritids hold, by reason of their septal structure, and generally of their skeleton, an isolated position amongst living Madreporaria. A similar position is occupied amongst Mesozoic corals by the Triassic family of Spongiomorphidæ. It seems likely that these two are ancestrally related; but I have not been able to do more than suggest a possible Palæozoic ally in the Theciidæ. Provisionally, I give the name of Porosa to the Poritids and Spongiomorphids, in reference to the porous network of trabecular parts which makes up the entire skeleton.

In summing up these points, I may say it is not my intention to erect Haplophractic and Pollaplophractic sub-orders of Madreporaria according to septal structure, since I know nothing in the nature of things to prevent the more advanced of the living genera whose septa are Haplophractic in type, to attain in the course of evolution to the Pollaplophractic type. All the more, since such an evolutionary change seems actually to have taken place among the early Cyathophyllids. In my estimation, the most scientific treatment of Madreporaria is to classify them into families only, at the same time bearing in mind, as I have indicated, the close similarities existing between certain groups of families. My plan of Madreporarian ancestry is represented in the accompanying diagram, and is more fully carried out in a phylogenetic "scheme" of genera given in the complete work (*Phil. Trans. R.S*, vol. clxxxvii. (1896) p. 331)

I have purposely devoted the greater part of the space in this account to septal structure; other points can be merely indicated. The wall displays all the structural types just described for septa The structure of the "wall" in fossil genera has an important bearing on questions concerning the "Randplatte." (I translate this term as "edge-zone.") It can be observed, for example, that in the early corals *the wall is the inner lining of the epitheca*, and the epitheca there extends up to the very lip of the calyx. The wall is therefore, like the tabula, primitively a one-sided structure. Both are laid down by continuous parts of the polypal ectoderm, and are skeletal forms homologous with the primitive inner lining of the embryonic basal skeletal plate. There cannot, therefore, have been any edge-zone of polypal flesh outside the calycinal wall of these early corals. Indication of an edge-zone is given when the wall in fossil genera is seen to rise up above the epithecal mantle at the edge of the calyx. It is then a two-sided structure developing within a fold, as in the case of septa. But the two flaps of the wall-fold may be quite different in length, as is testified by the varying position—central or excentric—taken by the "dark line" or fold-axis in the wall. This incoming of the edge-zone in corals took place at different times, and only in some genera; in others there has never been an edge-zone, so far as fossil evidence goes.

Speaking generally, I regard cœnenchyme as an elaboration or extension of mural and murocostate structures, formed above or within the epitheca.

I have above referred exclusively to the kind of wall which has been termed a "eutheca" (Fig. 8) or "true theca." Dr. Ortmann has defined it as a wall having distinct centres of calcification independent of these in the septa. In the case of

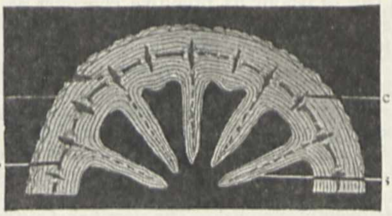


FIG. 8.—*Eutheca.* Transverse section showing the structural relations of *s.*= septa, *c.*= costa, *th.*=theca, and *ep.*= epitheca, in a typical Turbinolid. The section is cut some little distance below the calycinal edge.

the primitive one-sided wall, I would remark that the layers are often so smooth, that no particularly marked ring of "centres" is seen next the epitheca.

The "pseudotheca" (Fig. 9) is defined as a "false wall" formed by lateral thickening of the septa, with or without the participation of basal structures. I find that "pseudothecal" thickening is a very general characteristic in the families with

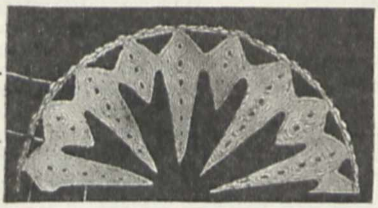


FIG. 9.—*Pseudotheca.* Transverse section showing the structural relations between *s.*= septum, *c.*= costa, *ps.th.*= pseudotheca, and *ep.*=epitheca. All grades occur between a position of the pseudotheca very near the centre and very remote from it, until it may be almost coalescent with the epitheca; the costa is respectively longer or shorter.

Pollaplophractic septa. Two walls, *i.e.* both pseudotheca and eutheca, were present temporarily or permanently in many fossil colonial genera belonging to Cyathophyllidæ, Stylinidæ, Amphiastræidæ, but, as a rule, the permanent presence of a pseudotheca is correlated with retrogression or absence of the primitive wall-lining of the epitheca, and even the epitheca itself, around individual calyces.

Evolution in the general Architecture of the Calyx.

The internal construction of the calyx has altered very considerably during the history of the Madreporaria. Originally, the Madreporarian calyx was shallow, with low septa ribbing the walls and base, and from one to four grooves (fossulæ) in the wall and base. Now, it has become typically deep-cupped, the septa are relatively higher and more ornate, centrally a columellar "style" rises upwards, or the septal ends meet irregularly in a columellar mesh-work, and instead of one to four special grooves, it is as if the whole base of the cup were grooved and deepened. These changes I take to be correlated, *and to have been initiated by an increase in the number of mesenteries bearing reproductive organs, and increase in the demand for space in which to accommodate and protect these organs in the calyx.* It is generally presumed that the primitive fossulæ were pits for the accommodation of a very few mesenteries specialised for reproduction. Whereas now all, or nearly all of the mesenteries in living corals can exert this function. The multiplication of reproductive organs in any species is, we may safely argue, an advantage to it in propagating its kind; certainly it is a change which has proved successful in all Madreporarian families adopting it. The Cyathophyllids were the most precocious of the Palæozoic corals in modifying their calyx; and I attribute to this fact the marvellous rapidity with which their descendants, the families of Astræidæ and Fungidæ, spread over early Mesozoic seas. To this day these families are probably the richest in genera and species.

The change in the architecture of the calyx was effected by a gradual modification of existing skeletal structures. The "tabula" degenerated or was changed to "columella"; it was only retained in its primitive form in the calyces of polyps which have never specially multiplied the number of their mesenteries, but have held their place owing to some other advantageous resource, *e.g.* cœnosarc. These are comparatively few.

The wall-lining of the epitheca was modified as I have indicated above. The septa were modified, giving rise to pseudothecæ inside the calyx, a valuable means for the support of mesenteries. In living families, the complicate Pollaplophractic type of septum goes hand in hand with much pleating and greater muscular vigour of the mesenteries. There can be little doubt that higher musculature and sensibility of mesenteries aids reproduction, hence these correlated features in septa and mesenteries were probably adaptations to this end. The synapticular base is another modification closely associated with the mesenteries, occurring as an occasional correlate in types with Pollaplophractic septa and a much-pleated aboral polypal surface.

In short, by comparison with well-known facts in the anatomy of living Madreporaria, it becomes clear that all the important changes which have taken place in the history of the group, are secondary features correlative with change in the mesenteries. There is also good evidence that the change in the mesenteries has assisted the polyp's powers of propagation. We need look no further for an explanation of the "hastening" in the stages of cyclical development of mesenteries or septa. The history of the embryo summarises that of the race; tetrameral symmetry is now for the most part an evanescent phase in embryonic development. On this point, any evidence I have gathered from Mesozoic corals only corroborates the published views of Prof. Quelch and Dr. Ortmann against a subdivision of Madreporaria into Tetracoralla (Rugosa) and Hexacoralla, and helps to still more emphatically knit continuity into the thread of Madreporarian descent from Palæozoic to recent time. Even now the change to radial symmetry of the polyp is often incomplete, and will be while there still are "directive" mesenteries.

In conclusion, I claim in this work to have shown that the great impulse of evolution—viz. the successful continuation of the race—is the agent to whose steady working the main changes in Madreporaria may be traced. I claim to have vindicated this position by demonstrating the same structural unit in the simplest and the most complicate skeletal structures known in Madreporaria through all ages, by finding in all skeletal parts one and the same fibrous equivalent of the living, lime-forming, unit cell, and by tracing a correlated series of modifications which primitive forms have undergone in response to the need of safeguarding the race. MARIA M. OGILVIE.

THE POSITION AND WORK OF THE CENTRAL TECHNICAL COLLEGE.

THE Report of the Special Committee appointed by the Governors of the City and Guilds of London Institute, at the instance of the Court of Assistants of the Mercers' Company, to inquire into the expenditure of the Central Technical College as compared with results, has just been published. The Committee comprised not merely representative members of the City Companies, but present and past Presidents of the Royal Society, the Institution of Civil Engineers, the Chemical Society, and other societies interested in the advancement of knowledge, so that its opinion may be regarded as that of the scientific public. Sir John Donnelly was elected chairman of the Committee.

The volume runs into eighty pages, and deals with (1) building and equipment, (2) current expenses, (3) cost of the College per student and comparison with other colleges, (4) methods of administration and control over expenditure. We are glad to give it prominence, first, because the Central Technical College is not supported as a commercial concern to make money, but to provide, at small cost, a sound education in the applications of the principles of science to industry; and secondly, because the members of the teaching-staff are earnest and enthusiastic in their efforts to carry ont the scheme formulated some years ago, when the estimates of the cost of the College were drawn up by Huxley and others.

It would be a distinct impediment to the progress of the higher technical teaching, if the present scheme (which supplies education to students at one-third of the annual cost, or for about one sixth of the total cost if interest on capital expenditure be added) were interfered with, by the obstruction offered by those who would prefer that the City Companies' funds should be spent on food for the body rather than for the mind.

From the Report of the Sub-Committee on Finance and Administration the following particulars have been derived :—

The Central Technical College was completed in 1884, and cost £79,200. The original equipment cost £22,600; making a total of £101,800.

In the following table is given the original capital expenditure on the College as compared with the capital expenditure estimated by the Livery Companies' Committee of 1878, in consultation with the expert advisers, together with capital expenditure on other colleges in England and abroad—

Central Technical College		£101,800
Approximate cost as suggested by—		
Prof. Huxley	£100,000	
Sir Douglas Galton ...	150,000	
Sir John Donnelly ...	100,000	
Sir H. Truman Wood...	150,000	
Mr. Bartley, M.P. ..	75,000	
King's College		215,970
University College		300,000
Owens College, Manchester		313,525
Yorkshire College, Leeds (buildings only) ...		167,000
University College, Liverpool		128,750
McGill University, Montreal (Engineering and Physics Departments only)		202,000
Cornell University		550,000
Massachusetts Institute of Technology		210,000
Technical High School, Berlin (building only), 1884		450,000
Technical High School, Munich, 1884		193,000
École Centrale des Arts et Manufactures, Paris (building only)		250,000

Since the original equipment of the Central College was furnished, a further sum of £9500 has been spent on apparatus, books and fittings of a permanent character, partly out of the general funds of the Institute, and partly out of special grants.

It is instructive to notice the cost to the College per student in comparison with other Colleges.

In England, Cooper's Hill Engineering College provides a training in engineering and forestry for about 100 students, more especially with reference to the requirements of the Indian Service; the College is under the India Office, and the gross cost per student amounts to about £170 a year; this, however, includes residence, the cost of which does not exceed £50 per student. The Royal College of Science, under the Science and Art Department, is attended by about 300 students, about half of whom are free scholars; the cost, exclusive of scholarships and exhibitions, is estimated for the current year at £20,364 (Civil Service Estimates), but this does not appear to include charges for rates, repairs, or library. The amount received for fees is about £3200, leaving the net cost at about £16,800. The gross and net cost per student is therefore about £67 and £57 respectively.

In the United States, America, the technical school which most nearly resembles the Central Technical College in its organisation is the Massachusetts Institute of Technology, at Boston, which, however, includes in its curriculum, in addition to the subjects of civil, mechanical and electrical engineering and chemistry, taught at the Central Technical College, several others which in England are provided for at the Royal College of Science, besides sanitary engineering, architecture, and shipbuilding. The courses of study cover a period of four years, and the total number of students is between 1100 and 1200. The institute has several buildings, each about the size of the Central Technical College. The expenditure in 1894 was £70,610—namely, salaries £41,900, laboratories and library £6760, and sundries £21,950. The income derived from the students' fees, £44,190. The gross and net cost per student was about £60 and £22 respectively. The gross annual cost per student at Cornell University, where science and engineering students greatly preponderate, is about £63; the number of students during the session 1894–5 was 1503, and the income derived from fees £30,000, or on an average £20 per student, making the net cost per student about £43. The income and expenditure of the Johns Hopkins University, Baltimore, was in 1893–4 £36,250, and the number of students in 1894–5, 589; the fees charged to students vary from £30 to £40. The gross and net cost per student would therefore be about £61 and £25 respectively.

At the McGill University, Montreal, the expenditure of the Faculty of Applied Science for the session 1895–6 amounted to £60 per student, and the net cost per student, after deducting receipts from fees, to £29.

The organisation of, and conditions of admission to, the technical high schools or polytechnics of Germany are so different from the Colleges just mentioned, that no accurate comparison can be drawn between them; but the following statement from the second Report of the Royal Commission on Technical Education, 1884, is of interest as showing what Germany was at that time doing for technical education:—"It may be mentioned that in the polytechnics of Germany there is accommodation for about 6000 students, whilst the total attendance is little more than 2000, and the annual cost to the State of each student, exclusive of interest on capital, is about £100" (vol. i. p. 209). Since that Report of the Commissioners, the accommodation in Germany for technical students has greatly increased, and at Charlottenberg (Berlin) alone there are over 2000 students, including, however, occasional students. The fees at the technical high schools in Germany amount, for a full attendance, to about £12 a year.

Perhaps the most celebrated polytechnic on the continent is that at Zurich, Switzerland, which in its organisation closely resembles the Central Technical College, although several times as large, and embracing a much wider range of courses of study. Her Majesty's Secretary of Legation at Berne, in a recent report on education in Switzerland, states that—"In the Polytechnic School of Zurich, to which the Federal Government makes an annual grant of £36,800, there are 720 pupils, of which 309 are foreigners. Instruction is given in architecture, civil engineering, mechanics, chemistry, forestry, and training of teachers. The fees are about £8 10*s*. per pupil." Assuming that there is no other source of income, this would make the gross and net cost per student about £59 and £50 respectively.

The foregoing approximate results, excluding board and lodging, are shown in the following table:—

—	No. of students.	Gross cost per student.	Net cost to Institute per student.
		£	£
Central Technical College ...	210	54	31
ENGLAND—			
Cooper's Hill	100	120	—
Royal College of Science...	300	67	57
AMERICA—			
Massachusetts Institute ...	1200	60	22
Cornell University ...	1503	63	43
Johns Hopkins University	600	61	25
McGill University (applied science only)	175	60	29
GERMANY—			
(Report of Royal Commission, 1884)	2000	—	100
SWITZERLAND—			
Polytechnic, Zurich ...	720	59	50

The Sub-Committee on the educational work of the College report that three classes of students attend the courses. There are those who hope to qualify for the diploma and take the three years' course of instruction as laid down in the programme; those who attend one or more departments only with a view of completing or continuing their instruction in special directions; and those who attend short courses of lectures or laboratory work in some special branch of applied science.

The questions set at the entrance or matriculation examination of the Central Technical College during the last few years show that no institution in the kingdom requires from candidates for admission the same standard of attainments. Indeed, with the exception of two institutions, none of those receiving any part of the Government Grant of £15,000 a year allocated to University Colleges, require students above sixteen to submit to any entrance examination whatever, and the examination of these two is of the simplest character, and bears no comparison with that of the Central Technical College. The Committee considers, therefore, that the Central Technical College is somewhat handicapped in its competition for students by the difficulty of its matriculation examination. At the same time they are of opinion that it is important that an institution, avowedly intended for higher education, should require candidates for admission to pass such an entrance examination.

There is another class of students for whom provision was made in the original scheme, in attendance at the College, who are not required to pass the matriculation examination, nor to take any prescribed course of study These are the so-called "special" students. They are in most cases students of more advanced age, who are desirous of pursuing for a session, or even a part of a session, a special line of study, with a view to qualifying for some particular industrial position or for teaching purposes, or for research work. Of such students, some have graduated at other universities, here or abroad; others have already been engaged in commercial works; and the evidence received from former students of this class satisfies the Committee as to the advantages derived from the facilities which the Central College offers for such specialised study. The gain to industry and commerce, and to the progress of science by the steady work and the careful researches of such students, is alone ample justification for the expenditure which the maintenance of an institution affording such facilities involves.

Although the number of students in attendance at the College cannot be considered, by itself, a sure criterion of its success, there is no other institution in Great Britain or Ireland in which so large a number of student are receiving advanced instruction of the same character as that given at the Central Technical College.

In considering the educational work of the College, the large number of contributions to the advancement of science which have been made by the Professors individually and in co-operation with their students are referred to. Indeed the spirit of research pervades every department of the College.

The teaching is well calculated to give to the student that general knowledge of scientific principles which all practical men regard as of primary importance, supplemented by the experience in the application of those principles to the methods of original investigation.

The knowledge which the students are enabled to acquire in the engineering workshops, of the construction and use of machine and other tools, is especially useful in subsequently helping them in their own experimental work, and in enabling them to profit more quickly by the experience of the factory or workshop.

As regards the salaries of the Professors, that there are four Professors who each receive a fixed stipend of £1000 a year without any share in the students' fees. At most other Colleges the practice is to give the Professor a smaller salary and a share in the fees. Both practices have advantages; but the Committee are disposed to give the preference to the system adopted by the City Guilds—of making the Professor quite independent of his students' fees, so that he may have no interest in admitting unqualified and insufficiently prepared students into the College. Indeed, with a difficult entrance examination, such as that of the Central College, the fact that the Professors' remuneration depends in no way upon the fees paid by the students removes any suspicion of a tendency to undue leniency on their part in the admission of the students. Several of the Professors in other institutions are more highly remunerated, and enjoy at the same time a larger measure of liberty than those at the Central Technical College. At Liverpool, the payment to the Professor of Physics for the year 1894-5 was £1177 16*s.* 7*d.*; to the Professor of Engineering £1039 17*s.* 7*d.* At University College, London, the payment to the Professor of Chemistry for the same year was £1100 13*s.* 4*d.* At Owens College, Manchester, the Professor of Mathematics received £1048 6*s.* 8*d.*; the Professor of Chemistry £1220 13*s.* 8*d.* At the Scotch Universities the salaries of the Science Professors are considerably higher.

The Educational Committee, finally, express their opinion that the work of the College has been eminently successful, and that the City Guilds Institute is to be congratulated on what it has accomplished. The results achieved are, in their opinion. fully commensurate with the expenditure involved.

Having regard to the higher appreciation of the advantages of advanced technical instruction, which a further knowledge of what is being done on the continent and in the United States is likely to bring about, it is believed that in the near future, the Central Technical College will be found too small for the number of students who, attracted by the excellence of the training it offers, will seek admission, and that the question of the extension of the building may before long have to be considered.

The Reports of the Sub-Committees on Finance and Administration, and on the Educational Work of the College, were adopted by the Committee. To sum up the case, this Committee reports that, in their opinion, the Governors of the City and Guilds of London Institute possess in the Central Technical College an Institution which has well and economically carried out the objects for which it was founded; and that those objects are well deserving of every support and encouragement that the Corporation and City Companies of London can give to them.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Dr. James Ward, whose name is well known as a physiological psychologist, was on Saturday elected to the new Professorship of Mental Philosophy and Logic. Dr. E. Barclay-Smith has been appointed Senior Demonstrator, and F. C. Kempson Junior Demonstrator in the department of Anatomy. Dr. J. N. Keynes has been appointed by the Council of the Senate to act on the joint committee for promoting legislation on secondary education now sitting in London. Mr. Yule Oldham, University Lecturer in Geography, is this term lecturing on the geography of Central Europe, and also (in conjunction with Mr. J. E. Marr, F.R.S.) on the scientific study of scenery. The geographical classes have of late been larger than in any previous year, and Mr. Oldham is steadily gaining ground for his subject in the University. Certain changes in the Historical Tripos will lead students to devote more of their time to political geography, and a new section of the higher local examination deals with the wider aspects of the science. The studentship of 100*l.* offered by the Royal Geographical Society to members of the University attending his lectures, will be awarded at the end of the present term. Mr. W. Bateson, F.R.S., of St. John's College, is this term giving a special course of lectures on the study of variation, which he has made peculiarly his own. A Shuttleworth Scholarship of 55*l.* a year for three years will be awarded at Gonville and Caius College in March. The subjects are botany and comparative anatomy, and candidates must be medical students of not less than eight terms' standing.

LORD WANTAGE, Mr. Richard Benyon, and Mr. Herbert Sutton have each given 1000*l.* to the building fund of the University Extension College, Reading. Mr. G. Palmer, Mr. G. W. Palmer, Mr. W. Palmer, and Mr. A. Palmer have each contributed 500*l.* for the same object, and the Drapers' Company have promised 1000*l.* on condition that a sum of 12,000*l.* is raised without delay. The Hampshire County Council have voted 1000*l.* out of accumulated surplus for the foundation of exhibitions in connection with the College.

THE following are among recent announcements:—Dr. Wilhelm Valentiner, formerly director of the astronomical observatory at Karlsruhe, to be professor of astronomy at the University of Heidelburg, whither that observatory has been removed; Dr. v. Buchka has taken up his residence at Berlin as successor to the late Dr. Eugen Sell in chemistry; Mr. J. G. Luehmann, for many years assistant to the late Baron von Mueller in the Government Botanist's Department, to be curator of the Melbourne Herbarium; Prof. B. Hatsheck, of Prague, to the chair of zoology in the University of Vienna, vacant by the resignation of Prof. K. Claus; Prof. Th. Curtius, of Kiel, to be professor of chemistry at Bonn, in succession to the late Prof. Kekulé; Dr. P. E. Study, associate professor of mathemathics at Bonn, to be professor of mathematics at Greifswald; Dr. G. A. Tawney, Princeton, to be professor of philosophy in

Beloit College, Wisconsin; Dr. S. Kalischer to be professor of physics in the Technical High School at Charlottenberg; Dr. W. Autenrieth to be provisional successor to the late Prof. Baumann in the chair of physiological chemistry in the University of Freiburg, in Baden.

AT the ordinary general meeting of Convocation of the University of London, on Monday, the report of the annual committee was adopted. The recommendations of a sub-committee, appointed to consider the possibility of rendering the library and laboratory of the University more available for general use, came up for discussion. A motion was carried expressing regret at the lack of a University Hall, which compelled the Senate to use the library for purposes for which it was not intended, and asking the Senate to consider whether steps could not be taken to remove the limitations which exist to the free use of the library. The sub-committee reported that the chemical and physical laboratories of the University are, *qua* laboratories, non-existent; but no remedies for these defects were suggested. It was pointed out that a complete and radical reorganisation is needed in the equipment of the University before its laboratories can be regarded as adequate for even the restricted purposes of examination, to say nothing of those of teaching or research. Indeed, the sub-committee doubts whether a laboratory equipped for the purpose of examination can properly be used for teaching or research. The Council of the Royal Botanic Society have offered a site, free of cost, for the erection of a students' observatory in connection with the University, together with the use of a lecture-room. The report of the annual committee adds that boards of studies in the subjects of physics, chemistry, botany, modern languages and literatures, mental and moral science, classics, political economy, and zoology are now actively engaged in the revision of the various syllabuses.

A STRONG committee, representing the leading associations concerned with technical and secondary education in this country, was formed last October to consider the ways and means of promoting legislation for secondary education. The committee has now unanimously adopted a number of resolutions, and submitted them to the Lord President of Council. Among the resolutions are the following: (*a*) In order to bring the State into a fitting relation to secondary education, it is necessary to provide for the constitution of a central authority suitable for this purpose (under a Minister of Education, when appointed), simultaneously with the provision of local educational authorities. (*b*) To this central authority should be transferred the powers and functions at present exercised by the Education Department and the Science and Art Department, so far as they relate to secondary education. In the opinion of this committee, it is of urgent importance that the Charity Commission should, as soon as possible, be included in the central authority, so far as its educational functions are concerned. (*c*) The central authority should include an educational council constituted on the principle laid down in the Teachers' Registration Bill of 1896, which council, in addition to the duties imposed on it in that Bill, might advise the Minister on the schemes for the constitution of local authorities and other matters referred to it by him. (*d*) There should be created a local authority for secondary education in every county or county borough, but in no areas smaller than these. Adjoining counties and county boroughs to have power to unite. (*e*) Scholarships and exhibitions should be tenable at, or open to the pupils of, any efficient school or institution; and this should not be regarded as aid to the school or institution within the meaning of the Act. (*f*) It is desirable that the legislation proposed should include a Bill, similar to the Bill of last Session, for the purpose of registering teachers qualified to teach in secondary schools, with this modification, that the third group of representatives of teachers on the registration council should be elected by persons not included in groups 1 and 2.

SPEAKING at a dinner given by the Drapers' Company, on Thursday last, to "meet the Lord President of the Council and the Incorporated Association of Head Masters," the Duke of Devonshire sketched the position of the Government with regard to secondary education. In the course of his remarks, he said: —"This would not, I think, be a fitting opportunity on which I should attempt to discuss the measure which I trust may at no distant date be introduced bearing upon this subject by Her Majesty's Government. But I think I may safely say that when the time comes when Parliament will be called upon to deal with this question a very considerable agreement will be found to exist as to the principles—the general principles—I will not say the details—upon which it should be founded. I believe that the principles which have been laid down in the report of the Royal Commission on Education, which was published a year, or a little more than a year ago, have met as to their general lines —I refrain altogether from saying as to their details—with the general approval and the consent of those who have been concerned either in an administrative or a professional capacity with this subject. You will remember that those lines were, generally speaking, drawn in local rather than in centralised directions, and that while the necessity has been admitted for unifying and concentrating many of those educational forces, which are at present unduly and unnecessarily dispersed, the Commissioners have carefully borne in mind the necessity of doing nothing to injure that which they themselves have described as the rich variety of our educational life, or to impair the individual energy and activity which has actuated it. These are the principles which I believe and trust will underlie any measure which the Government may ultimately feel itself able to introduce. As to what needs to be done, there is first the necessity of remodelling the central authority, which probably may be done rather by administrative than by legislative methods, exercising powers which will be chiefly those of superintendence, revision, and advice, but for the exercise of which the central authority ought to combine the knowledge of endowed schools, of organised science schools, of science and art schools, of higher grade Board schools, which is now possessed by various and separate departments of the Government. Secondly, I think we are all pretty universally agreed that it is necessary to constitute some local authorities administering the secondary education over areas of sufficient extent; and, thirdly, something in the nature of an educational council ought to form part of the central authority, although it would have to exercise, not administrative, but purely consultative functions."

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, January 11.—M. A. Chatin in the chair.—The Secretary announced to the Academy the loss it had sustained in the death of Dr. Gould, Correspondant in the Section of Astronomy.—Notice on the scientific work of Benjamin Apthorp Gould, by M. Lewy.—Researches on the composition of French and foreign wheat, by MM. Aimé Girard and E. Fleurent.—Observations on the periodic Brooks' comet (1889 *v*-1896 *c*), and the comets of Giacobini (1896 *d*), Brooks-Spéra (1896 *e*), Perrine (1896 *f*), and Perrine (1896 *g*), made with the longe equatorial of the Observatory of Bordeaux, by MM. G. Rayet, L. Picart, and F. Courty.—Remarks by M. Armand Gautier, on presenting to the Academy a copy of his work on normal and pathological biological chemistry.—Alimentary hygiene; red and white wine, by M. P. Carles.—Note on a project for crossing Central Europe by an aerostat, by MM. G. Besançon and E. Aimé.—The rarefaction of air in balloons, by M. O. Julien.—New nebulæ discovered at the Paris Observatory, by M. G. Bigourdan.—Observations on shooting stars of December 12, 1896, made at Athens, by M. D. Egenitis. —Remarks on the method of Gauss for the determination of the orbits of the small planets, by M. J. Perchot.—Distances of the solar system, by M. Delauney.—On the movement of a solid in an indefinite liquid, by M. R. Liouville.—Some remarks on a note by M. Delsol, entitled "On a thermic machine," by M. H. Pellat. The reasoning in question would make the machine described of higher efficiency than that given by the application to the case of the second law of thermodynamics. Two objections are raised to the arguments given by M. Delsol.—On the variation of the melting point with pressure, by M. R. Demerliac. The rate of change of melting point with pressure has been experimentally studied for paratoluidine, and for α-naphthylamine. The values obtained are in complete agreement with those given by the formula of Clapeyron, involving the latent heat of fusion and change in the specific volume.—On the absolute value of the magnetic elements on January 1, 1897, by M. Th. Moureaux.—On the density of ozone, by M. Marius Otto. The same flask was filled successively with dry oxygen and ozonised oxygen, and weighed, the amount of ozone present being after determined with suitable precautions by means of an acidified solution of potassium iodine. The density found was ⅔ that of oxygen, within the limits of experimental error.—Decomposition of metallic sulphates by hydrochloric acid, by M. Albert Colson.—On the polymerisation of some cyanic compounds, by M. Paul-Lemoult. Correcting some thermochemical calculations given in a previous note.—Dimorphism of the optical isomerides of the succinates of camphol, by M. J. Minguin.—Action of potassium cyanide upon the 1 : 4 lactones, by M. Edmund Blaise.—Phosphoric ethers of allyl alcohol, by M. J. Cavalier.—On a difference between high and low yeasts, by M. P. Petit. The two kinds of yeast show differences in their behaviour towards nitrogenous foods.—Contribution to the study of the coagulating ferment of the blood, by MM. A. Dastre and N. Floresco.—Refractory period in the nervous centres, by MM. André Broca and Charles Richet.—Evolution of the Monstrillidæ, by M. A. Malaquin.—On the relations existing between the *Discopoma comata* (Berlese) and *Lasius mixtus* (Nylander), by M. Charles Janet.—On the development of the white rot in the vine (*Charrinia diplodiella*), by M. P. Viala.—The Swiss Rhone tributary of the Rhine, by M. Maurice Lugeon.—On the differential equations of the second order, with several independent variables, by M. A. J. Stodolkiewitz.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 21.

ROYAL SOCIETY, at 4.30.—On Cheirostrobus, a New Type of Fossil Cone from the Calciferous Sandstone: Dr. D. H. Scott, F.R.S.—(1) Experiments in Examination of the Peripheral Distribution of the Fibres of the Posterior Roots of some Spinal Nerves, Part II.; (2) Cataleptoid Reflexes in the Monkey; (3) On Reciprocal Innervation of Antagonistic Muscles (third note): Prof. Sherrington, F.R.S.

ROYAL INSTITUTION, at 3.—Some Secrets of Crystals: Prof. H. A. Miers, F.R.S.

LINNEAN SOCIETY, at 8.—On the Origin of the Corpus callosum; a Comparative Study of the Hippocampal Region of the Cerebrum of Marsupialia and certain Cheiroptera: Dr. G. Elliott Smith.—On the Minute Structure of the Nervous System of the Mollusca: Dr. J. Gilchrist.

CHEMICAL SOCIETY, at 8.—Studies of the Properties of Highly Purified Substances. I. The Influence of Moisture on the Production of Ozone from Oxygen and on the Stability of Ozone. II. The Behaviour of Chlorine, Bromine, and Iodine with Mercury. III. The Behaviour of Chlorine under the Influence of the Silent Discharge of Electricity and in Sunlight: W. A. Shenstone.—Action of Diastase on Starch, Part III.: A. R. Ling and J. L. Baker.—The Solution Density and Cupric-reducing Power of Dextrose, Levulose, and Moist Sugar: Horace T. Brown, F.R.S.; Dr. G. Harris Morris; J. H. Millar.—Derivatives of Maclurin, Part II.: A. G. Perkin.

GRESHAM COLLEGE, at 6.—Milk, Meat, and Oysters as Carriers of Disease: Dr. Symes Thompson.

FRIDAY, JANUARY 22.

ROYAL INSTITUTION, at 9.—Properties of Liquid Oxygen: Prof. Dewar, F.R.S.

PHYSICAL SOCIETY, at 5.—An Exhibition of some Simple Apparatus by W. B. Croft.—On the Passage of Electricity through Gases: E. C. Baly.

GRESHAM COLLEGE, at 6.—Diphtheria: Dr. Symes Thompson.

SUNDAY, JANUARY 24.

SUNDAY LECTURE SOCIETY, at 4.—Life on the Surface of Water: Prof. L. C. Miall, F.R.S.

MONDAY, JANUARY 25.

SOCIETY OF ARTS, at 8.—Material and Design in Pottery: W. Burton.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—An Expedition across Spitzbergen: Sir W. Martin Conway.

INSTITUTE OF ACTUARIES, at 7.—Rates of Mortality in certain Parts of Africa: A. E. Sprague.

CAMERA CLUB, at 8.15.—The Zamanass for Registering High Velocities: Sir C. Purcell Taylor, Bart.

TUESDAY, JANUARY 26.

ROYAL INSTITUTION, at 3.—Animal Electricity: Prof. A. D. Waller, F.R.S.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Diversion of the Periyar: Colonel J. Pennycuick, R.E.

ANTHROPOLOGICAL INSTITUTE, at 8.—Anniversary Meeting.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Architectural Photography: Ernest Marriage.

WEDNESDAY, JANUARY 27.

BRITISH ASTRONOMICAL ASSOCIATION, at 5.

THURSDAY, JANUARY 28.

ROYAL SOCIETY, at 4.30.—The following Papers will *probably* be read:—On the Capacity and Residual Charge of Dielectrics as affected by Temperature and Time: Dr. J. Hopkinson, F.R.S., and E. Wilson.—On the Electrical Resistivity of Electrolytic Bismuth at Low Temperatures and in Magnetic Fields: Prof. Dewar, F.R.S., and Prof. Fleming, F.R.S.—On the Selective Conductivity exhibited by certain Polarising Substances: Prof. J. C. Bose.

ROYAL INSTITUTION, at 3.—Some Secrets of Crystals: Prof. H. A. Miers, F.R.S.

SOCIETY OF ARTS, at 8.—The Mechanical Production of Cold: Prof. James A. Ewing, F.R.S.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—Electrical Interlocking, the Block, and Mechanical Signals on Railways: F. T. Hollins.

FRIDAY, JANUARY 29.

ROYAL INSTITUTION, at 9.—The Polarisation of the Electric Ray: Prof. J. C. Bose.

INSTITUTION OF CIVIL ENGINEERS, at 8.—An Experimental Investigation of the Efficiency of a Pelton Waterwheel: S. Henry Barraclough.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

BOOKS.—Onoranze al Prof. S. Cannizzaro. Rendiconto Generale (Roma).—Smithsonian Physical Tables: T. Gray (Washington).—The Practical Photographer, Vol. 7 (Lund).—Our Weights and Measures: H. J. Chaney (Eyre).—An Introduction to the Study of Chemistry: Drs. W. H. Perkin and B. Lean (Macmillan).—Colliery Surveying: T. A. O'Donahue (Macmillan).—Fruit Culture for Amateurs: S. T. Wright (Gill).—The Hemiptera-Hemoptera of the British Islands: J. Edwards (L. Reeve).—Black-board Drawing: M. Swannell (Macmillan).—Microscopic and Systematic Study of Madreporarian Types of Corals: Dr. M. M. Ogilvie (Dulau).—Among British Birds in their Nesting Haunts: O. A. J. Lee, Part 2 (Edinburgh, Douglas).—Den Norske Nordhavs-Expedition, 1876–78. xxii. Zoologi, Tunicata: A. Huitfeldt-Kaas (Christiania, Grondahl).—A Manual of Elementary Seamanship: D. Wilson-Barker (Griffin).—Getting Gold: J. C. F. Johnson (Griffin).—Pioneers of Evolution from Thales to Huxley: E. Clodd (Richards).—Travels in West Africa: Mary H. Kingsley (Macmillan).—A Year in the Fields: C. Johnson (Smith, Elder).—Diseases of Plants induced by Cryptogamic Parasites: Dr. K. F. von Tubeuf; English Edition by Dr. W. G. Smith (Longmans).—On Mechanical Selection and other Problems: Dr. K. Jordan.

PAMPHLETS.—Exposition Nationale Suisse. Catalogue illustré Chasse et Pêche (Genève).—The Climate of Bournemouth in relation to Disease, especially Phthisis: Dr. A. Kinsey-Morgan (Bristol, Wright).—To Winnipeg, Manitoba, and Back: S. Marriott (Simpkin).—Das Wesen der Elektrizität und des Magnetismus: J. G. Vogt (Leipzig).—Exercises in Practical Physiology. Part 1. Elementary Physiological Chemistry: A. D. Waller and W. L. Symes (Longmans).

SERIALS.—Lloyd's Natural History. British Birds, Parts 8 and 9: Dr. R. B. Sharpe (Lloyd).—Strand Magazine, January (Newnes).—Geological Magazine, January (Dulau).—Mind, January (Williams).—Proceedings of the Incorporated Society of Psychical Research, December (K. Paul).—Proceedings of the Physical Society, December (Taylor).—Journal of Anatomy and Physiology, January (Griffin).—Morphologische Jahrbuch, 24 Band, 4 Heft (Leipzig, Engelmann).—Psychological Review, January (Macmillan).—The British Moss-Flora, November: Dr. R. Braithwaite (the Author, Clapham Road).—Lean's Royal Navy List, January (Witherby).—The Bachelor of Arts, December (N.Y.).—L'Anthropologie, November-December (Paris, Masson).—Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus, Nos. 7, 8, 9 (Asher).—American Journal of Mathematics, Vol. xix. No. 1 (Baltimore).—The Engineering Magazine. January (Tucker).—Quarterly Review, January (Murray).—Journal of the Franklin Institute, January (Philadelphia).

CONTENTS. PAGE