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*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH

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HELMHOLTZ ON THE AXIOMS OF GEOMETRY

THE *Academy* journal of the 12th of February, 1870 (vol. i. p. 128), contained a paper by Prof. Helmholtz upon the Axioms of Geometry in a philosophical point of view. The opinions set forth by him were based upon the latest speculations of German geometers, so that a new light seemed to be thrown upon a subject which has long been a cause of ceaseless controversy. While one party of philosophers, especially Kant and the great German school, have pointed to the certainty of geometrical axioms as a proof that these truths must be derived from the conditions of the thinking mind, another party hold that they are empirical, and derived, like other laws of nature, from observation and induction. Helmholtz comes to the aid of the latter party by showing that our Axioms of Geometry will not always be necessarily true; that perhaps they are not exactly true even in this world, and that in other conceivable worlds they would be entirely superseded by a new set of geometrical conditions.

There is no truth, for instance, more characteristic of our geometry than that between two points there can be only one shortest line. But we may imagine the existence of creatures whose bodies should have no thickness, and who should live in the mere superficies of an empty globe. Their geometry would apparently differ from ours; the axiom in question would be found in some cases to fail, because between two points of a sphere diametrically opposite, an infinite number of shortest lines can be drawn. With us, again, the three angles of a rectilineal triangle are exactly equal to two right angles. With them the angles of a triangle would always, more or less, exceed two right angles. In other imaginary worlds the geometrical conditions of existence might be still more strange. We can carry an object from place to place without necessarily observing any change in its shape, but in a spheroidal universe nothing could be carried about without undergoing a gradual distortion, one result of which would be that no two adjoining objects could have a similar form. Creatures living in a pseudo-spherical world would find all our notions about parallel lines incorrect, if indeed they could form a notion of what parallelism means. Nor is Helmholtz contented with sketching what might happen in purely imaginary circumstances. He seems to accept Reimann's startling speculation that perhaps things are not as square and right in this world as we suppose. What should we say if in drawing straight lines to the most distant fixed stars (by means not easy to describe), we found that they would not go exactly straight, so that two lines, when fitted together like rulers, would never coincide, and lines apparently parallel would ultimately intersect? Should we not say that Euclid's axioms cannot hold true? It may be that our space has a certain twist in a fourth dimension unknown to us, which is inappreciable within the bounds of the planetary system, but becomes apparent in stellar distances.

Though Helmholtz gives most of these speculations as due to other writers, he seems, so far as I can gather from his words, to stamp them with the authority of his own high name. It requires a little courage, therefore, to maintain that all these geometrical exercises have no bearing whatever upon the philosophical questions in dispute. Euclid's elements would be neither more nor less true in one such world than another; they would be only more or less applicable. Even in a world where the figures of plane geometry could not exist, the principles of plane geometry might have been developed by intellects such as some men have possessed. And if, in the course of time, the curvature of our space should be detected, it will not falsify our geometry, but merely necessitate the extension of our books upon the subject.

Helmholtz himself gives the clue to the failure in his reasoning. He says: "It is evident that the beings on the spherical surface would not be able to form the notion of geometrical similarity, because they would not know geometrical figures of the same form but different magnitude, except such as were of infinitely small dimensions.' But the exception here suggested is a fatal one. Let us put this question: "Could the dwellers on a spherical world appreciate the truth of the 32nd proposition of Euclid's first book?" I feel sure that, if in possession of human powers of intellect, they could. In large triangles that proposition would altogether fail to be verified, but they could hardly help perceiving that, as smaller and smaller triangles were examined, the spherical excess of the angles decreased, so that the nature of a rectilineal triangle would present itself to them under the form of a limit. The whole of plane geometry would be as true to them as to us, except that it would only be exactly true of infinitely small figures. The principles of the subject would certainly be no more difficult than those of the Differential Calculus, so that if a Euclid could not, at least an Archimedes, a Newton, or a Leibnitz of the spherical world would certainly have composed the books of Euclid, much as we have them. Nay, provided that their figures were drawn sufficiently small, they could verify all truths concerning straight lines just as closely as we can.

I will go a step further, and assert that we are in exactly the same difficulty as the inhabitants of a spherical world. There is not one of the propositions of Euclid which we can verify empirically in this universe. The most perfect mathematical instruments are not two moments of the same form. We are practically unacquainted with straight lines or rectilineal motions or uniform forces The whole science of mechanics rests upon the notion of a uniform force, but where can we find such a force in operation? Gravity, doubtless, presents the nearest approximation to it; but if we let a body fall through a single foot, we know that the force varies even in that small space, and a strictly correct notion of a uniform force is only got by receding to infinitesimals. I do not think that the geometers of the spherical world would be under any greater difficulties than our mathematicians are in developing a science of mechanics, which is generally true only of infinitesimals. Similarly in all the other supposed universes plane geometry would be approximately true in fact, and exactly true in theory, which is all we can say of this universe. Where parallel lines could not exist of finite magnitude, they would be conceived as of infinitesimal magnitude, and the conception is no more abstruse than that of the direction of a continuous curve, which is never the same for any finite distance. The spheroidal creatures would find the distortion of their own bodies rapidly vanishing as the distance of the motion is less, which only amounts to the truth, that a small portion of an ellipse is ultimately undistinguishable from a circle. The truth of the Axioms of Geometry never really comes into question at all, and Helmholtz has merely pointed out circumstances in which the figures treated in plain geometry could not always be practically drawn.

It is a second question whether the dwellers in a spherical world could acquire a notion of three dimensions of space. We must remember that such beings could bear no analogy to us, who have solid bones and flesh, and live upon a solid globe, into which we can penetrate a considerable distance. These beings have no thickness at all, and live in a surface infinitely thinner than the film of a soap bubble, in fact, not thin or thick at all, but devoid of all pretensions to thickness.

There would be nothing at first sight to suggest the threefold dimensions of space, and yet I believe that they could ultimately develop all the truths of solid geometry. They could not fail to be struck with the fact that their geometry of finite figures differed from that of infinitesimals, and an analysis of this mysterious difference would certainly lead them to all the properties of tridimensional space. Indeed, if Riemann, prior to all experience, is able to point out the exact mode in which a curvature of our space would present itself to us, and can furnish us with analytical formulæ upon the subject, why might not the Riemann of the spherical world perform a similar service, and show how the existence of a third dimension was to be detected? It might well be that the inhabitants of the sphere had in the infancy of science never suspected the curvature of the world, and, like our ancestors, had considered the world to be a great plain. In the absence of any experience to that effect, it is certain that the notion of thickness could not be framed any more than we can imagine what a fourth dimension of our space would be like. We have some idea what a world of one dimension would be, because as regards *time* we are in a world of that kind. The characteristic of time is that all intervals beginning and ending at the same moments are equal. But suppose that some people discovered a mysterious way of living which enabled them to live a longer time between the same moments than other people; this could only be accounted for by supposing that they had diverged from the ordinary course of time, like travellers taking a roundabout road. Though in one sense such an occurrence is utterly inconceivable, yet in another sense we can probably anticipate the character of the phenomenon, and the 47th proposition of Euclid's first book would doubtless give the most important truth concerning times thus differing in direction.

With all due deference to so eminent a man as Helmholtz, I must hold that his article includes an *ignoratio elenchi*. He has pointed out the very interesting fact that we can conceive worlds where the Axioms of our Geometry would not apply, and he appears to confuse this conclusion with the falsity of the axioms. Wherever lines are parallel the axiom concerning parallel lines will be true, but if there be no parallel lines in existence, there is nothing of which the truth or falsity of the axiom can come in question. I will not attempt to say by what process of mind we reach the certain truths of geometry, but I am convinced that all attempts to attribute geometrical truth to experience and induction, in the ordinary sense of those words, are transparent failures. Mr. Mill is another philosopher whose views led him to make a bold attempt of the kind. But for real experience and induction he soon substituted an extraordinary process of *mental experimentation*, a handling of ideas instead of things, against which he had inveighed in other parts of his "System of Logic." And the careful reader of Mr. Mill's chapter on the subject (Book II. chapter 5) will find that it involves at the same time the assertion and the denial of the existence of perfectly straight lines. Whatever other doctrines may be true, this doctrine of the purely empirical origin of geometrical truth is certainly false.

W. STANLEY JEVONS

LEIGHTON'S LICHEN-FLORA OF GREAT BRITAIN

The Lichen-Flora of Great Britain, Ireland, and the Channel Islands. By the Rev. W. A. Leighton, F.L.S. (Published for the Author. Shrewsbury, 1871.)

IT falls so rarely to the botanical reviewer in this country to notice works on Lichenology, that we gladly avail ourselves of the present opportunity of introducing to our readers a little unpretentious volume which has the excellent object primarily—"of elevating the knowledge of our insular lichens to a level with that of other branches of our country's flora," and which, moreover, completely vindicates the title of Britain's lichens to at least equal study with the other families of her cryptogamia. Since the publication of Mudd's excellent "Manual" in 1861, the additions made to the lichen-flora of Great Britain and Ireland have been both so numerous and important, that lichenological students have felt the want of some systematic work containing a complete list of the British lichens up to the present date, along with specific diagnoses and other aids to their identification. It was generally felt, moreover, that no fitter authority could undertake so intricate a labour than Mr. Leighton, whose name is identified with lichenological progress in this country by the publication of many important papers of a monographic character, and who is justly regarded, both by home and foreign botanists, as the representative and father of lichenology and lichenologists in Britain. The present work, which we are glad to find is to be followed, in due time, by another which is even more urgently required —a Conspectus of all known lichens throughout the world—is a convenient 12mo volume of about 470 pages, which confines itself mainly to a systematic enumeration, with specific diagnoses, of all the lichens at present known to occur in "Great Britain, Ireland, and the Channel Islands." The nomenclature and classification followed are those of Dr. Nylander, of Paris, who is described as "the *facile princeps* of modern microscopic lichenologists." Succeeding the specific diagnoses, the author cites the leading synonyms; gives references to published plates and fasciculi of dried specimens; narrates the general geographical distribution of species throughout the world, on the one hand, and throughout the three kingdoms on the other; specifies the particular localities of growth in each of these latter kingdoms; and gives, so far as possible, the date of original discovery in Britain, with the name of the discoverer.

Besides the fruits of laborious compilation, the work obviously contains a large amount of original research. There are no less than seventy-five species, varieties, or orms, described for the first time (though not necessarily in this volume) by Mr. Leighton himself; many of these referring, however (as in the case of the *Graphideæ*), to varieties or forms that do not apparently require separate description and nomenclature. He has also given great attention to the action of certain chemical substances on the thallus and apothecia, and has to a considerable extent employed the said reaction in his minor classification. Only those who have attempted similar works can understand the immense labour involved in their preparation; and British botanists ought to feel, and doubtless do feel, themselves under great obligations to Mr. Leighton for undertaking and successfully executing so difficult a task. The present work has been published at Shrewsbury for and by the author himself—a procedure which enables a writer to escape the irksome and mischievous fetters sometimes imposed by publishers. But this circumstance—of local publication—is apt to be attended with certain countervailing disadvantages; so that in the present instance it does not surprise us that the typography, paper, and binding—the general up-get of the volume—do scant justice to all the author's labours in its compilation.

It is always an ungracious task to expose faults in a work that is, on the whole, excellent; that has been a labour of love; that embodies the fruit of much research; and that could have been fitly undertaken by very few individuals. But Mr. Leighton himself apparently invites co-operation, if not criticism, in order to the preparation of a fuller and more accurate second edition; and his present work contains defects of a character that seriously mar its usefulness to the student, and that no honest reviewer, if he is to be critical at all, would be warranted in passing without notice. It is then a very serious defect of the book that it contains no Index of Species and Varieties, alphabetically arranged after the manner of that in Mr. Crombie's Enumeration. For small genera, containing not more than half a dozen species, it may be comparatively easy to find *varia* or *communis*, or any other type; but in large genera such as *Lecanora*, *Verrucaria*, and *Lecidea*, each containing from 73 to 233 species, the student must carefully read that number of names, spread over 53 to 110 closely printed pages in each case, before he finds perhaps the species of which he is in search. Only the most ardent lichenologist, who has abundant leisure as well as patience at command, will care to take this amount and kind of trouble. The omission referred to is of such importance that we counsel Mr. Leighton to lose no time in issuing a full and legible Index of species and varieties as a supplement to the present work; and to avail himself of the opportunity, which we trust its rapid sale and extensive circulation will give him, of inserting such an Index in its proper place in a second edition. The form of the said Index should be that adopted by Crombie in his Catalogue of the British Lichens (1870), and not that of Mudd, in his Manual (1861), which is infinitely less easy to use.

In his present work, Mr. Leighton assumes too high a previous standard of technical knowledge on the part of the student. How many beginners in lichenology are likely to know—without being informed—what our author means by a "glypholecine" epithecium, or "bacilliform" spores? In fact, there ought to be a Glossary, to explain the meaning of the technical terms employed throughout the work; and this is the more necessary, seeing that, unlike Mudd in his "Manual," Mr. Leighton gives no Introduction explanatory of the general structure and morphology of lichens. Further, the student cannot be expected to know by intuition the meaning of the abbreviations used by the author, such as B.; Bohl.; Zw.; M. and N.; Arn.; Fellm; Th.M. Fr.; Flk. D.L.,; Nyl. Syn., Scand. or Pyr.; Hepp sporen; and so forth. There ought certainly to have been prefixed a full explanation of all these, and similar, contractions; which explanation would necessarily include a comparatively complete and most useful Lichen Bibliography. Again, there is no standard of form, size, or colour. We are told that certain spores are large, moderate, small, minute, or very minute; and certain spermatia long, shortish, or shortly cylindrical. But in no case are measurements given; and the student has to form his own opinion as to the signification of these unscientific, vague, relative terms. He is left, moreover, to conjecture as to what constitute the "positive" and "negative" reactions of hydrate of potash and hypochlorite of lime; and as to what is a "vinous" reaction of the hymenial gelatine with iodine!

The work professes to give a "*full* diagnosis" of each species. But that surely cannot be considered a *full* diagnosis, which systematically omits almost all reference to the important Secondary Reproductive Organs? In not a single species, so far as we have been able to discover, is there a full description of the *Spermogones*! *Pycnides* are not once mentioned in the volume! No doubt in one or two species the character of the *spermatia* is sketched by a single term, or by other inadequate means. Thus in *Opegrapha amphotera* the spermatia are said to be "different from *O. vulgata*;" but we are not told what is their character in *O. vulgata*. There are certain large and important genera in which the spermogones are not at all mentioned even in the diagnosis of the genus (*e.g.*, *Verrucaria*, *Cladonia*, *Collema*, *Leptogium*, *Opegrapha*, and *Graphis*); while in others such a description as "Spermatia various" (*e.g.* in the *Ramalinei*) conveys little or no real information! In a very few exceptional instances, among the higher Lichens, are spermogones or their contents described. Where the attempt is made, the result is singularly bald and unsatisfactory, and is obviously not the fruit of original investigation. And, further, the beginner will scarcely understand what is meant by crenated, oblong cylindrical, straight, curved, or slender spermatia, without plates, which are wholly wanting in the present volume. A student cannot be said to have acquired a "knowledge" of Lichens, who is ignorant of the characters of their *Spermogones* and *Pycnides*. To the biologist or physiologist, therefore—to him whose object is to study the whole Natural History of a given Lichen-species—such omissions in a systematic work on a national Lichen-flora is one of primary importance. The author tells us that he aims at descriptions, which will "*facilitate the student* (*sic.* the italics being ours) in the ready and accurate determination of his *specimens*;" that is to say, the naming or ticketing of them, which is something very different from imparting a knowledge of all their natural characters! The truth is that such works as the present are calculated not to create Biologists, but to perpetuate a race of mere collectors and labellers—men whose highest aim is to gather "new" or "rare" species; who spend their holidays in accumulating *specimens*, sending those that are unfamiliar across the Channel for identification or naming. One of the results of the latter procedure is that the present work contains no less than 200 British species or varieties bearing Nylander's name as the author of their first description!

While, however, meagre attention has been thus bestowed upon the secondary reproductive organs, undue prominence is given to the action of potash and lime on the thallus and apothecia, and the reaction of iodine with the hymenial gelatine; phenomena that are so uncertain and inconstant that they vary even in the same individual under different circumstances. We would not *exclude* chemical or *any* natural characters from the definition of species; but the present work seems to us to furnish ample illustration of the danger of making use of secondary, trivial, inconstant characters as a basis for classification (*e.g.* the genus *Cladonia.*)

The localities of growth are satisfactory so far as they go; but they are utterly inadequate as representing the distribution of species in either of the three kingdoms. In order to specify, with at all adequate fulness, the diversity of locality occupied in England, Scotland, and Ireland respectively by the species enumerated, Mr. Leighton must have examined for himself the contents of all the Lichen-Herbaria in these kingdoms; and, though the said herbaria are neither numerous nor large, compared with those of flowering plants, such a labour is obviously impossible for any *one* man of average leisure and opportunities.

There is no Tabular Summary showing the numerical richness of the British Lichen-Flora; an omission, it may be, of minor importance, but still of importance, inasmuch as it is always interesting to "take stock" occasionally of the rate of progress of the additions that are being made to a national Sub-Flora. Basing our calculations on the data supplied by the present work, we find a total of 73 genera and no less than 781 species; whereas only last year in his enumeration, Crombie (p. 124), gave the whole number of British Lichens then known as 658, the difference apparently representing, or consisting of, so-called *new* species. Of the host of these *new* species added of late years to our Lichen-Flora, perhaps not above one-fifth will survive in that "struggle for existence," to which they will sooner or later have to submit at the hands of the philosophic botanist. A large proportion will doubtless be found to consist of *mere forms of common, protean, widely distributed species*—forms that neither require nor deserve separate nomenclature and rank.

We have not exhausted the list of blemishes in the book before us. But to notice *all* the errors in matters of detail; all those points on which other lichenologists are likely to take grave exception to his views; all the faults in typography or otherwise, would extend and expand this review into a Treatise on the Classification of Lichens; for it would necessarily deal with certain features of that Nylanderian system, which Mr. Leighton follows in his present work.

With all the aids the author gives the student, it will, we fear, be impossible for the latter to identify the majority of the less common and familiar species without reference to authentic specimens named by Mr. Leighton himself. The work is so elaborate and complex, the principles and practice of classification adopted in it are so puzzling, that we candidly confess our own general impression to be one of increasing bewilderment, and of growing indisposition to attempt the identification or nomenclature of Lichens at all! We hesitate not to avow our own preference for studies on the Biology of the common economical species, such as those which *at present* are called *Cladonia rangiferina*, *Usnea barbata*, *Ramalina calicaris*, *Parmelia saxatilis*, *Roccella tinctoria*, or *Lecanora tartarea.*

On the whole, however, the "Lichen-Flora of Great Britain" is a work that should find a place in every public botanical library in the three kingdoms, as well as in the private libraries of all students of the extremely puzzling cryptogamic family of which it treats.

W. LAUDER LINDSAY

OUR BOOK SHELF

A Complete Course of Problems in Practical and Plane Geometry, adapted for the Use of Students preparing for the Examinations, &c. By John William Palliser, Second Master and Lecturer of the Leeds School of Art and Science. (London: Simpkin and Marshall.)

A NEW class-book on Practical Geometry commends itself to our attention. Mr. John Palliser, of the Leeds School of Art and Science, has produced one of those educational works which a demand created by Government examinations has recently brought to our aid. Reserving our opinion as to the final tendency of an epidemic for what are called practical results, we must, in justice, say that this class-book of Mr. Palliser's is the very thing for cheapness, conciseness, comprehensiveness, to rapidly possess the student with a ready-handed ability to answer all demands of the examiner. The work is not encumbered with demonstration, for this, in view of the proposed end, would be out of place; it is a laboratory of experimental formulæ. We have a recipe for constructing all conceivable polygons within the compass of a single circle, for drawing lines to invisible points, and for trisecting the most obdurate angles by the magic of a slip of paper. Faith is all that is demanded of the student, faith in the formulæ before him, and industry to get them by heart. Not troubled with the Why, he has only to remember the How; but he must be careful, exact, and neat-handed; and this, if not mental training, is next of kin to it. The arrangement of the book is generally good, the style concise in the extreme, the letter-press wonderful at the price, and the diagrams, with their faint, dark, or dotted lines, are highly effective and intelligible, not less so from the fact of the *lettering* being (what we very seldom find it) correct.

To examine in detail the 220 problems of Mr. Palliser's book is more than we can just now undertake; but so far as we have dipt into them there is little to complain of, considering that the work is merely practical. The style, we have said, is concise; but (if we might venture a criticism on a point where most geometers are more guilty than Mr. Palliser) it would lose nothing in intelligibility if the nominative case were less frequently preceded by a multitude of perplexing conditions which really have to be neglected by the learner till the said nominative is reached, and then returned to lastly in that natural order of thought which geometers have a fancy for inverting. Whilst taking these minor exceptions, we must not omit to call the author's serious attention to Problem 13, which, whether we consult the diagram or the letter-press, is wholly fallacious. Such a construction will not effect the object of the problem, the bisection of the angle, though the line H K will converge in common with the two given lines. We must further enter protest against the *unqualified* proposal "to draw a straight line equal to the true length of the circumference of a circle" (Prob. 184) as misleading to the learner. But, any such defects notwithstanding, here is a most wonderful eighteenpenny book.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his Correspondents. No notice is taken of anonymous communications.*]

Geometry at Oxford

In the last number of NATURE Mr. Proctor remarks that "no one who considers carefully the mathematical course at either University, can believe that it tends either to form geometricians or to foster geometrical taste."

With regard to Oxford, I think it is only fair that some qualification should be offered to this conclusion. In Cambridge, candidates for mathematical honours have to run their race in a course clearly marked out for them, and loss of place is naturally the result of individual vagaries. But in Oxford the order of merit is not carried further than distribution into classes, and I do not believe there is anything to prevent a skilful geometrician finding himself in the first class with those who put their trust most in analytical methods.

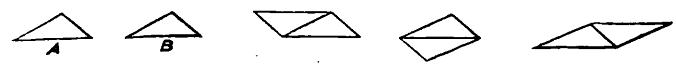
I cannot pretend to much geometrical capacity, but I know something of Oxford mathematical teaching. Speaking for myself, the fascinating lectures of the present Savilian Professor of Geometry will never cease to hold perhaps the most prominent place in my recollections of university work. It is quite true that I remember conversing with a college tutor who was rather doubtful about modern geometrical methods, and seemed disposed to look upon these lectures as "dangerous." He was a great stickler, however, for "legitimacy," thinking it wrong, for example, to import differential notation into analytical geometry; but I do not think he had a large following amongst younger Oxford men. I certainly did not find, in reading with some of them, that geometry was at all in disfavour. I have often had neat geometrical solutions pointed out to me of problems where other methods proved cumbrous or uninteresting; and conversely I have found geometrical short cuts were far from objected to. On the whole, the characteristic feature of the Oxford examination system (most marked in the Natural Science School, but making itself felt in all the others) being to encourage a student after reaching a certain point in general reading to make himself strong in some particular branch of his subject, I believe special attention to geometrical methods would pay very well.

Oct. 13 W. T. THISELTON DYER

Elementary Geometry

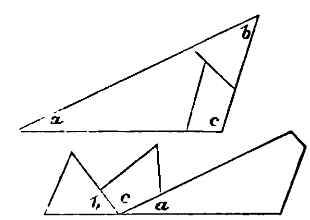
YOUR correspondent, "A Father," has in view a very desirable object—to teach a young child geometry—but I fear that he is likely to miss altogether the path by which it may be reached. His principle, that "a child must of necessity commit to memory much that he does not comprehend," appears to me to be totally erroneous, and not entitled to be called a fact. To this time-hallowed principle it is due that a large proportion of all who go to school learn nothing at all, while those more successful learn with little improvement of their faculties. It is a convenient principle which allows the title of teacher to be assumed by those who only hear lessons. Children labour under this difficulty that they learn only through language, which is to them a misty medium, particularly when the matter set before them is in any degree novel or abstruse, and no pains are taken to clear up the obscurity of new expressions. Children know nothing of abstraction, and learn to generalise from experience, not from words. Committing to memory what is not understood is a disagreeable task; begetting a hatred of learning, and causing many to believe that they want the special faculty required for the task set before them. The art of teaching the young ought to be the art of enabling them to comprehend, and memory ought to be strengthened not by drudgery but by being founded on understanding and by the rational connection of ideas.

Now geometry is the science of figure; it theorises reality, and the truth of every proposition in it may be made apparent to the senses. Double a piece of paper and cut out a triangle in duplicate. The two equal triangles thus formed, A and B, may be put together so as to form a parallelogram in three different ways. The child who makes this experiment will learn at once



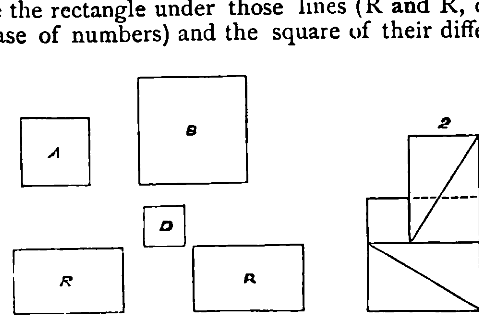
what is meant by a parallelogram, and he will perceive its properties, viz., that its opposite sides and angles are equal; that it is bisected by the diagonal, &c. But if he learns all this by rote, he acquires only a cloud of words, on which his mind never dwells. Propositions touching abstractions and generalisations can never be understood by the young without abundant illustration. When a geometrical truth is made apparent to the senses, when seen as a fact and fully understood, the language in which it is expressed having no longer a dim and flickering light, is easily learned and remembered, and the learner listens with pleasure to the discussion of the why and wherefore.

It is not enough for a child to learn by rote the definition of an angle. He ought to be shown how it is measured by a circle; and by circles of different sizes. In short, he ought to be taught what words alone will not teach him, that an angle is only the divergence of two lines. Let us now come to the important theorem that the three angles of any triangle are equal to two right angles (Euclid i. 32). Cut a paper triangle, mark the angles, then separate them by dividing the triangle and place the three angles together. They will lie together, filling one side of a right line, and thus be equal to two right angles. Let the learner test the theorem with triangles of every possible shape to convince himself of its generality, and then, fully understanding what it means, he will also understand the language in which it is proved.



It is a mistake to decry the use of symbols. They enable us to get rid of the wilderness of words, which form a great impediment in mathematical reasoning. Ordinary language can never group complex relations for comparison so compactly as to bring them within the grasp of the understanding. When we would compare objects, we place them close together, side by side. But the features and lineaments of objects described in language are too widely scattered to be kept steadily in view. It is easier to learn the use of symbols than to commit to memory what is not understood. Those who would learn mathematics without symbols can advance but a little way.

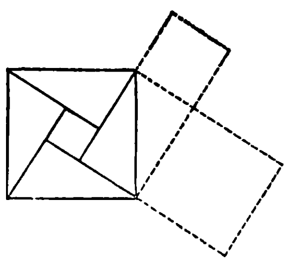
Neither is there any good reason for rejecting the second book of Euclid, though it certainly may be much abridged. The relations of whole and parts, sum and difference are easily exhibited, and an acquaintance with them is of great value to arithmeticians. Let us take for example the following propositions: "The squares (A and B) of any two lines (or numbers) are equal to double the rectangle under those lines (R and R, or the product in case of numbers) and the square of their difference D."

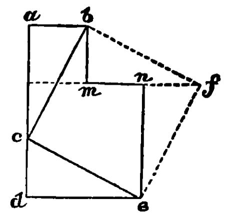


Now these figures being constructed, it will be found that when the two squares are placed together as in Fig. 2, the rectangles cover exactly the parts marked with diagonals, and the square of the difference the remainder.

In numbers, the square of 5 =	25
" 3 =	9
	34
Double product of 5 and 3	30
Square of diff.	4
	34

Here is a perfect demonstration evident to the senses. But let us go one step further. The rectangles in the preceding theorem may be bisected by diagonals and set round the square of the difference in such a manner as to form the square of the hypothenuse of the right-angled triangle, the sides of which are also those of the assumed squares. The squares of the sides of a right-angled triangle, therefore, are together equal to the square of the hypothenuse, since the former may be changed into the latter.





The same conclusion may be arrived at by a still shorter and simpler course. Let any two squares be joined together as in the annexed figure, or, rather, let them be cut in paper in one piece. Then take *a c* equal to the side of the greater square, and join *b c* and *c e*. Cut off the two equal triangles *b a c* and *c d e*, and place them in the positions of *b m f* and *f n e*, and the two squares will be thus transformed into the square of the hypothenuse of the right-angled triangle, of which they form the sides.

Thus we have at once a demonstration of the famous Pythagorean theorem (Euclid i. 47), and have attained with three or four steps the same height climbed by Euclid with forty-seven. The words of his demonstration, committed to memory by a child, remain there mere words and nothing more. Words serve to mark and denote ideas, but cannot create them, where the material of ideas does not already exist. But the child who with paper or card amuses himself in going over the visible demonstration suggested in this letter, in various forms and repeatedly—for neither old nor young can be said to learn a truth merely by its transient recognition—will assuredly awaken to an agreeable consciousness of the reasoning faculty, and feel no difficulty in future geometrical studies.

In 1860 there was published for me, by Messrs. Williams and Norgate, a little volume entitled, "The Elements of Geometry Simplified and Explained," adapted to the system of empirical proof, and of exhibiting the truth of theorems by means of figures cut in paper. It contained in thirty-five theorems the quintessence of Euclid's first six books, together with a supplement of thirty-three not in Euclid. There was no gap in the sequence or chain of reasoning, yet the 32nd and 47th provisions of Euclid were respectively the 3rd and 17th of my series. This book proved a failure, for which several reasons might be given, but it will be sufficient here to state but one, namely, that it came forth ten years before its time. What became of it I know not. But of this I am convinced, that though I failed, success will attend those who follow in my footsteps. W. D. COOLEY

THE discussion in your last part on methods of teaching elementary geometry reminds me that at a period when I was teaching the subject to a considerable number of pupils, I frequently overcame the difficulties of very young or inapt students by commencing with the study of a *solid*, such as a cube, encouraging the pupils to frame definitions for the parts of the object. The ideas existing in the child's mind of a solid, a plane, a line, and a point, were thus put into words in an order the reverse of that in which they would have been had Euclid been used. The chief properties of parallelograms and triangles followed, and were easily *discovered* by the use of a pair of compasses, scissors, and paper, and that at an age when Euclid was a sealed book. I believe children can be most easily taught to solve problems in plane geometry when they occur in connection with early instruction in practical solid geometry. Most children try to draw, and if they were encouraged to represent simple objects by "plans" and "elevations," the necessity of obtaining a knowledge of how to describe the forms presented to them would frequently carry the pupils through a large number of the principal problems of plane geometry with a pleasure they could not experience if the "problems" were put before them, without any reason for their solution but the teacher's command. The powers of truthful representation gained by such teaching, would be of the utmost value to thousands who would never attempt to learn "Euclid;" whilst, so far as I am able to judge, it is more likely to prepare the boy to read formal works on geometry with pleasure than to create a distaste for the study.

THOMAS JONES

Woolwich, October 9

The Coming Eclipse

I HAVE been very much interested in Mr. Lockyer's lecture at the Royal Institution on the late eclipse. I am especially glad that he is at length able to acknowledge the existence of comparatively cool hydrogen, because in my Eclipse Report of 1868 (vol. xxxvii. Part 1, R.A.S. Memoirs), I stated that I believed from the evidence of the photographs that hydrogen was dispersed from the prominences in visible streams in some cases, and in others invisibly.

But while Mr. Lockyer admits this, he seems to me very unnecessarily to avoid everywhere the use of our familiar term "atmosphere" to include the whole gaseous envelope of the sun. This seems to me to be the sense in which Kirchhoff used the word when he said it was extensive.* It certainly was the sense in which I used it, and, I believe, that in which all who spoke of an extensive atmosphere did so use it. In this sense there can be no doubt that the sun *has* an extensive atmosphere, the outer portion of which is comparatively cold and capable of reflecting light if the polarisation now not doubted be due to reflection.

There is one consideration which, however, does not seem to have occurred to Mr. Lockyer. If the cold atmosphere, as I will venture still to call it, reflect the prominence light, it will also reflect the solar light. Its *reflected* light then should be such as reaches us at ordinary times, and not so exclusively chromospheric. Adding to this the light which is due to cool hydrogen, we should have, I anticipate, a faint continuous spectrum with the bright line F, and also a solar spectrum with, perhaps, some of the chromospheric lines reversed. That is not what has been found, and I do not at present see any way of reconciling the facts with the theory that the undoubted polarisation is due to reflection.

Before going to another subject, I would wish to direct attention to my friend Captain (now Major) Branfill's observations in 1868† on the polarisation of the corona. Mr. Proctor, indeed, in his book on the Sun, says that the Astronomer Royal did not consider them conclusive, but I have his official statement that he did so consider them, and an inquiry as to Mr. Proctor's authority leads me to think that Mr. Airy's meaning was mistaken. I think any one who reads the account in the original will feel that the plane of polarisation was satisfactorily determined. An observer in 1870 has said that he found the bands of Savart persistent. I have not now time to look up the reference, but he used, it seemed to me, the centre of the moon as the centre of rotation. Captain Branfill was careful not to do this, as his figures prove (page 25 of Report).

Now to the future. I have received from Government an inquiry as to recommendations to observers coming out. I am now suggesting, in addition to my own station at Dodabetta, that observers should be stationed at Kotagherry in the Nilgherries, at Manantoddy among the coffee districts to the west, and at Tirupur, close to Avenashy Road Station of the Madras Railway. Of these Manantoddy is the least accessible, but the whole will give a range of stations from 8,600 feet high down to the ordinary level of the plain country. More observers could be accommodated on the Nilgherries, where the weather, I am assured, is likely to be excellent. Of Ceylon I have not satisfactory accounts, nor of the west coast.

If these stations be adopted, I would suggest that, if possible, there should be a conference of observers. The possibility will depend on our leisure, which, probably, none of us can now oresee.

I should say that I have made these suggestions without reference to Mr. Pogson, because I know nothing of his plans, having received no answer to inquiries; it is possible those may modify projects, but any visitors should bear in mind that it is almost necessary that some European residences should be close to their stations. J. T. TENNANT

H.M. Mint, Calcutta, Sept. 11

* Mr. Lockyer has long ago shown that the Sun's atmosphere lies partly above and partly below the superior limit of the photosphere. The word Atmosphere was used by Kirchhoff in the manner indicated, because he believed the photosphere to be liquid.—ED.

† American observers seem never to have seen the Report.

British Mosses

NOT having noticed in the last number of NATURE, Oct. 12, any correction made by either the Rev. Mr. Berkeley or Dr. Dickie, of a statement made by the former gentleman in the previous number, Oct. 5, which, as it reads, is calculated to lead to error, if left unnoticed, I send you this note.

In the short paragraph at p. 446, "Notaris on Mosses," Mr. Berkeley, in correcting a previous omission having reference to the genus Habrodon, states that *Conomitrium julianum* had been sent to Dr. Dickie by Mr. Wilson from his district," Warrington. This being only one side of the truth, I take the liberty of supplying the other side. Any person reading the paragraph as it stands would certainly suppose that this very elegant, and very remarkable moss was a native of the Warrington district, which it is not, nor of any other part of the British Isles that I am aware of. No doubt Dr. Dickie received fresh specimens of the moss from Mr. Wilson at Warrington, as I also did, but they were of foreign origin, and only cultivated by Mr. Wilson in his little conservatory at Warrington, where he had them placed in a large-mouthed jar filled with water, in which condition I saw the plants during the month of October, 1870, on the occasion of the last visit I paid to my now departed friend.

I may further remark that I had been led to suppose it was Dr. Schimper, of Strasburg, who first made known the genus Habrodon to be British. In the summer of 1865 he and the late Mr. Wilson paid me a visit at Dublin, and after leaving Ireland, Dr. Schimper accompanied a party to the Highlands of Scotland, on which excursion the Habrodon was discovered growing on trees near Killin, whence I have specimens from the party, which were collected on that occasion.

Glasniven, Oct. 16 D. MOORE

Corrections

A PARENTHETICAL passage in my "note on the Cycloid" has been transposed. Instead of "(a luminous point for the nonce) the sun in the meridian," &c., it should have been "the sun (a luminous point for the nonce) in the meridian," &c.

In Mr. Abbott's paper on η Argus and its surrounding nebula there occurs the statement that I consider "an increased or decreased distance in space may account for the fluctuations of the nebula." I have never suggested such an explanation. What I have said is that the fluctuations, if real, would seem to suggest that the nebula has not those inconceivably vast dimensions which would correspond to the vast distance once assigned to it. My opinion was (and is), *not* that the nebula is nearer than it was formerly, but that it is nearer than it was formerly supposed to be. RICHD. A. PROCTOR

A Universal Atmosphere

WILL you permit me to ask Mr. Mattieu Williams how, on his hypothesis, "that the atmosphere is universal, and that each planet attracts to itself an atmosphere in proportion to its mass," he accounts for the well-known fact that the moon shows no signs of an atmosphere sufficient to produce any indication of refraction during the occultations of a star?

I think Mr. Williams's book deserves far more attention than it has received, so I trust I shall be acquitted of any wish to indulge in carping criticism. JOHN BROWNING

111, Minories, October 10

The Temperature of the Sun

HAVING been absent from home I have but just seen Mr. Ericsson's article on the "Temperature of the Sun" in NATURE, (No. 101, p. 449. All who feel an interest in the subject must be indebted to Mr. Ericsson for the experimental evidence which he has contributed to the investigation, and for such further light as his ingenuity will doubtless enable him to throw upon it; but few, I think, will be inclined to admit that the reasoning advanced in his recent article justifies in any degree the inferences which he has there drawn.

At the outset of the inquiry it does not seem very likely that we shall gain much correct knowledge of the condition of the solar atmosphere by inquiring what that condition would be if it were replaced by a medium similar to the terrestrial atmosphere, and containing the same quantity of matter for corresponding areas of the spherical surface. If the case were otherwise it would be necessary to point out that Mr. Ericsson's numerical results are vitiated by his omission to consider that the volume of a sphere varies as the cube of the radius, and therefore that on the data assumed by him the earth's atmosphere raised to the temperature of the solar surface, instead of attaining a height of 279,006 miles, would barely reach to one-twelfth of that limit.

But I may further remark that the assumptions on which Mr. Ericsson's calculations are founded are open to many objections. It is far from certain that the direct proportion between the increase of volume of gases at constant pressure and the increase of temperature, holds good for an enormously high temperature such as prevails in the solar atmosphere, and it is certain that the resistance offered by that medium to the passage of radiant heat depends not solely or mainly on its temperature, but on its chemical—*i.e.* its molecular—constitution.

It may further be noted that Mr. Ericsson's experiments on the diminution of heat emanating from a disc of incandescent iron, according to the angle at which its face is inclined to a fixed thermometer, do not justify similar conclusions with regard to heat emanating from a mass of incandescent gases or vapours. At the same time it may be regretted that Mr. Ericsson has not given fuller details respecting the experiments in question, which may give valuable results irrespective of the conclusions to which he has applied them. JOHN BALL

Flight of Butterflies

CAN you tell us where the yellow butterflies are going?

About ten days since, while chatting with several gentlemen at the Jackson Sulphur Well about caterpillars, one of them remarked that the worm was about, for, says he, the yellow butterflies are all going east.

We thought at first he was telling us a "fish story", but soon became convinced that he knew whereof he spoke, for while we sat there a great number of bright-coloured, medium-sized butterflies came by us, all winging their way towards the rising sun.

Now, we do not think that this fly is related to the caterpillar, for the moth that lays the egg of that destructive worm is a very different fly; nevertheless it is a singular fact that they are all going east.

I have been at several different points since leaving Jackson, and at every place they fly the same way. Can you tell us whither they go? Perhaps if you will ask the question in your widely-circulated journal, some naturalist, or somebody over to the eastward, may tell us where they rest. ALA

Mobile, Sept. 6

[A similar fact will be found recorded in our "Notes" respecting the *Urania leilus.*—ED.]

Velocity of Sound in Coal

THIS is a very interesting subject, at least to those who have anything to do with coal mines. And yet I have not met with anything that points to it, nor any formula whereby it might be calculated. But perhaps this is a subject to which the attention of physicists has not been drawn. I have been told that blasting has been heard at the distance of 150 yards underground, and I have heard the signals of the colliers, *i.e.*, by hitting the surface of the coal with one of their tools, at the distance of fifty or sixty yards, and have also heard the shouts of the men at the distance of fifteen yards; but I have never met any person who could give the velocity, nor seen any book on physics in which there is anything concerning it. But perhaps it is a very hard subject to deal with from the difference of the specific gravity of the coals, and also the different temperatures that we meet there. And if from these different causes it would be hard to find the real velocity, yet by calculating a velocity that might be rather theoretical at first, we might by degrees come nearer the truth.

D. JOSEPH

Ty Draw, Pontyfridd, Oct. 5

Prof. Newcomb and Mr. Stone

I AM obliged to Mr. Lynn for pointing out that the statement by "P. S." was contradicted. I had not been aware of this. It never occurred to me to doubt either the authorship or the authenticity of the statement. I cannot tell how it chanced that "W. T. L.'s" response escaped my attention. Perhaps I never saw the January number of the *Astronomical Register*; or, perhaps, a variety of other reasons which would not interest your readers.

The only point of the least interest in the matter (if the matter has any interest at all) is the fact that Prof. Newcomb did not discuss the observations of 1769, as I had believed. I have already admitted this, and withdrawn those expressions of commendation which I had founded on the strongly-worded letter of Prof. Smyth, so that I am rather at a loss to know what purpose Mr. Lynn had specially in view when he wrote his letter. I thank him, however, as warmly as though I knew what he meant.

RICHD. A. PROCTOR

SCIENCE AT THE UNIVERSITIES

THE following courses of lectures will be delivered at the University of Oxford in Natural and Physical Science during the ensuing term:—The Sedleian Professor of Natural Philosophy, the Rev. Bartholomew Price, M.A., will deliver a course of Lectures on Light, on Tuesdays, Thursdays, and Saturdays, at one o'clock, commencing October 19th, at the Lecture Room, Museum, Upper Corridor South. The Savilian Professor of Astronomy, the Rev. C. Pritchard, M.A., proposes to give two courses of lectures during the present term; the one on Astronomical Instruments, the other on the Lunar Theory. The Professor of Experimental Philosophy, R. B. Clifton, M.A., will give a course of Lectures on Experimental Optics, on Wednesdays and Fridays, at twelve o'clock, commencing October 20, at the Physical Laboratory, University Museum. The Physical Laboratory of the University will be open daily for instruction in Practical Physics, from ten to four o'clock, on and after Thursday, October 19. The Linacre Professor of Anatomy and Physiology, G. Rolleston, D.M., will lecture on Circulation and Respiration, on Tuesdays, Fridays, and Saturdays, at one o'clock, commencing October 20, at the Museum. The Professor proposes to form classes for Practical Instruction, as in former terms. Persons who join these classes will come to the lectures on Saturdays at one o'clock, and will also come to the Museum on three mornings in the week for study and demonstration, under the superintendence of Mr. Charles Robertson, the Demonstrator of Anatomy, and Mr. C. S. Taylor, of Merton College. The Hope Professor of Zoology, J. O. Westwood, M.A., will not lecture during the present term, being engaged in the classification of the Hope, Burchell, Bell, and other collections, at the New University Museum, where he will be happy to see gentlemen desirous of studying the Articulated Animals, daily, between 1 and 5 P.M. A course of lectures will be given on behalf of the Professor of Chemistry, by A. Vernon Harcourt, M.A., in continuation of the Professor's course, on Tuesdays and Saturdays, at eleven o'clock, commencing October 21, at the Museum. There will also be an Explanatory and Catechetical Lecture on Thursdays, at eleven o'clock, to commence on Thursday, October 26. The Laboratory of the University will be open daily for instruction in Practical Chemistry from 9 A.M. to 3 P.M., on and after Monday, October 16. The ordinary course of instruction in the laboratory includes those methods of Qualitative Analysis, a knowledge of which is required of candidates for honours in the School of Natural Science who make Chemistry their special subject. In addition to this two courses of instruction will be given in the Laboratory, the one on the Methods of Qualitative Analysis, the other a course of elementary practical instruction in Chemical Manipulation, intended for those commencing the study of Chemistry.

At Cambridge the following lectures in Natural Science will be delivered during Michaelmas Term in connection with Trinity, St. John's, and Sidney Sussex Colleges:—On Electricity and Magnetism (for the Natural Sciences Tripos), by Mr. Trotter, Trinity College, on Mondays, Wednesdays, and Fridays, at 10, commencing Wednesday, October 18. On General Physics, Sound, and Light (for the Natural Sciences Tripos 1872, and following years), by Mr. Trotter, Trinity College, on Tuesdays, Thursdays, and Saturdays, commencing Thursday, October 19. On Chemistry, by Mr. Main, St. John's College, on Mondays, Wednesdays, and Fridays, at 12, in St. John's College Laboratory, commencing Wednesday, October 18. Attendance on these lectures is recognised by the University for the certificate required by medical students previous to admission for the first examination for the degree of M.B. Instruction in Practical Chemistry will also be given. On Palæontology (the Protozoa and Cœlenterata), by Mr. Bonney, St. John's College, on Mondays, Wednesdays, and Fridays, at 9, commencing Wednesday, October 18. On Geology (for the Natural Sciences Tripos, preliminary matter and Petrology), by Mr. Bonney, St. John's College, on Tuesdays and Thursdays, at 9, commencing Thursday, October 19. A course on Physical Geology will be given in the Lent Term, and on Stratigraphical Geology in the Easter Term. Papers will be given to questionists every Saturday at 11. On Botany, for the Natural Sciences Tripos, by Mr. Hicks, Sidney College, Tuesdays, Thursdays, and Saturdays, at 11, beginning on Tuesday, October 31. The lectures during this term will be on Vegetable Morphology. Mr. Hicks will also give examination papers in Botany to candidates for the next Natural Sciences Tripos on Mondays, at 1 P.M., beginning October 30. These examinations will be free to those who have attended the botanical lectures of the last term. On the Elements of Physiology, by the Trinity Prælector in Physiology (Dr. M. Foster), Mondays, Tuesdays, and Wednesdays, at 11 A.M., commencing Monday, October 23. A course of Elementary Practical Physiology, on Wednesdays and Thursdays, commencing Wednesday, October 25, at 2 P.M.

AN EXPLOSION (?) ON THE SUN*

ON the 7th of September, between half-past 12 and 2 P.M., there occurred an outburst of solar energy remarkable for its suddenness and violence. Just at noon the writer had been examining with the telespectroscope an enormous protuberance or hydrogen cloud on the eastern limb of the sun.

It had remained, with very little change since the preceding noon, a long, low, quiet-looking cloud, not very dense or brilliant, nor in any way remarkable except for its size. It was made up mostly of filaments nearly horizontal, andfloated above the chromosphere, with its lower surface at a height of some 15,000 miles, but was connected to it, as is usually the case, by three or four vertical columns brighter and more active than the rest. Lockyer compares such masses to a banyan grove. In length it measured 3′ 45″, and in elevation about 2′ to its upper surface, that is, since at the sun's distance, 1″ equals 450 miles nearly, it was about 100,000 miles long by 54,000 high.

At 12.30, when I was called away for a few minutes, there was no indication of what was about to happen, except that one of the connecting stems at the southern extremity of the cloud had grown considerably brighter, and was curiously bent to one side; and near the base of another at the northern end a little brilliant lump had developed itself, shaped much like a summer thunder-head.

What was my surprise, then, on returning in less than half an hour (at 12.55), to find that in the meantime the whole thing had been literally blown to shreds by some inconceivable uprush from beneath. In place of the quiet cloud I had left, the air, if I may use the expression, was filled with flying *débris*—a mass of detached vertical fusiform filaments, each from 10″ to 30″ long by 2″ or 3″ wide

* From the *Boston Journal of Chemistry*, communicated by the author.

brighter and closer together where the pillars had formerly stood, and rapidly ascending.

When I first looked, some of them had already reached a height of nearly 4′ (100,000 miles), and while I watched them they rose with a motion almost perceptible to the eye, until in ten minutes (1.5) the uppermost were more than 200,000 miles above the solar surface. This was ascertained by careful measurement; the mean of three closely accordant determinations gave 7′ 49″ as the extreme altitude attained, and I am particular in the statement because, so far as I know, chromospheric matter (red hydrogen in this case) has never before been observed at an altitude exceeding 5′. The velocity of ascent also, 166 miles per second, is considerably greater than anything hitherto recorded.

As the filaments rose they gradually faded away like a dissolving cloud, and at 1.15 only a few filmy wisps, with some brighter streamers low down near the chromosphere, remained to mark the place.

But in the meanwhile the little "thunder head," before alluded to, had grown and developed wonderfully into a mass of rolling and ever-changing flame, to speak according to appearances. First it was crowded down, as it were, along the solar surface; later it rose almost pyramidally 50,000 miles in height; then its summit was drawn out into long filaments and threads which were most curiously rolled backwards and downwards, like the volutes of an Ionic capital: and finally it faded away, and by 2.30 had vanished like the other.

The whole phenomenon suggested most forcibly the idea of an *explosion* under the great prominence, acting mainly upwards, but also in all directions outwards, and then after an interval followed by a corresponding inrush: and it seems far from impossible that the mysterious coronal streamers, if they turn out to be truly solar, as now seems likely, may find their origin and explanation in such events.

The same afternoon a portion of the chromosphere on the opposite (western) limb of the sun was for several hours in a state of unusual brilliancy and excitement, and showed in the spectrum more than 120 bright lines whose position was determined and catalogued—all that I had ever seen before, and some fifteen or twenty besides.

Whether the fine aurora borealis which succeeded in the evening was really the earth's response to this magnificent outburst of the sun is perhaps uncertain, but the coincidence is at least suggestive, and may easily become something more, if, as I somewhat confidently expect to learn, the Greenwich magnetic record indicates a disturbance precisely simultaneous with the solar explosion.

C. A. Young

Dartmouth College, September 1871

THE KEA—PROGRESS OF DEVELOPMENT

A NOTICE of the development of a striking change in the habits of a bird may be considered by naturalists interesting enough to justify a brief record in your journal. The Kea (*Nestor notabilis*) may be seen and heard in certain localities amidst the wild scenery of the Southern Alps in the middle island of New Zealand, for it is not so rare as has been described. This fine bird belongs to one of our indigenous genera, an examination of its structure proves that it shares with the *Kaka* a claim to a position amongst the *Trichoglossinæ* or Brush-tongued Parrots; the under side of its thick tongue near the tip is fringed with papillæ, enabling it to collect the sweets of its favourite blossoms. Through how many years has this species been content to range over shrub-covered heights and rock-bound gullies, gathering its subsistence from the nectar of hardy flowers, from the drupes and berries of the dwarfed shrubs that contend with a rigorous climate, and press upwards almost to the snow line of our Alpine giants? To these food-resources may be added insects found in the crevices of rocks, beneath the bark of trees, and its aliment not wholly vegetarian, yet such as called forth no display of boldness in order to procure a sufficient supply. This peaceful demeanour was observed under the ascendency of Moaic conservatism. The European has been the means of corrupting the simplicity of its ancient habits; the meat-gallows of the back-country squatters attracted the attention of our mountain-parrots in the winter season. To them they became points of interest in their wanderings, and furnished many a hearty meal torn from the dangling carcass as it swung in the frosty air; neither were the drying sheepskins, stretched on the rails of the stockyard, neglected. The Paneka has been destined to supply the enterprising Kea with a dainty only equalled perhaps by that which the epicurean African cuts warm from his bovine victim—our *educated* bird now tears his food from the back of the living sheep. From a local paper one learns that, for the last three years the sheep belonging to a settler "in the Wanaka district, (Otago) appeared afflicted with what was thought to be a new kind of disease; neighbours and shepherds were equally at a loss to account for it, having never seen anything of the kind before. The first appearance of this supposed disease is a patch of raw flesh on the loin of the sheep, about the size of a man's hand; from this matter continually runs down the side, taking the wool completely off the part it touches, and in many cases death is the result. At last a shepherd noticed one of the mountain parrots sticking to a sheep and pecking at a sore, and that the animal seemed unable to get rid of its tormentor. The runholder gave directions to his shepherds to keep watch on the parrots when mustering on the high ground; the result has been that during the present season when mustering high upon the ranges near the snow line, they saw several of the birds surrounding a sheep which was freshly bleeding from a small wound in the loin; on other sheep were noticed places where the Kea had begun to attack them, small pieces of wool having been picked out."

From the recent settlement of the country, it would be quite possible to date each step in the development of the destructiveness of the Kea, the gradual yet rapid change from the mild gentleness of a honey-eater, luxuriating amidst fragrant blossoms when the season was lapped in sunshine, or picking the berried fruits in the more sheltered gullies when winter had sternly crushed and hidden the vegetation of its summer haunts. Led, perhaps, to relish animal food from its partly insectivorous habits, its visits to the out-stations show something like the bold thievery of some of the Corvidae, whilst its attacks on sheep feeding on high ranges exhibit an amount of daring akin to the savage fierceness of a raptorial. Is the position of Nestor in our avifauna an anomalous one? A sucker of honey, devourer of fruit, destroyer of insects, render and tearer of flesh—will the difficulty be met by classing our mountain bird as omnivorous, or is it to be considered as only one other instance in which system puzzles and hampers the field naturalist?

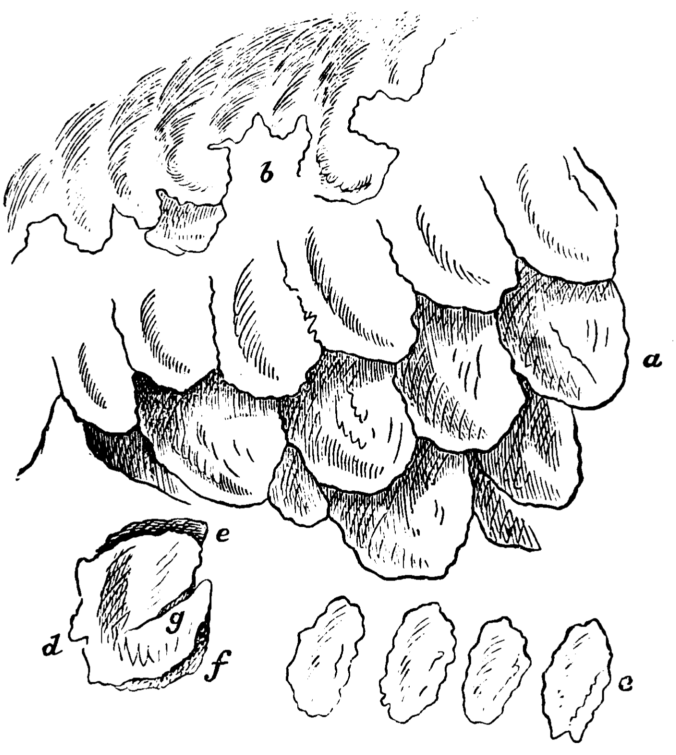
Thos. H. Potts

ON A NEW FORM OF CLOUD*

THE accompanying figure on p. 490, represents a form of cloud which I have seen but twice in my life;* the first time about the commencement of June 1871, at five o'clock in the evening, at Washington, U.S.; the second at Beloit, Wisconsin, U.S., during the same year, and at the same hour. The state of the atmosphere presented similar meteorological conditions at both times. The appearances coincided with

* See my new classification of clouds with sixteen engravings in the *Rural New Yorker*, January 29, February 26, April 9, May 21, June 4 and 11. It will be reprinted in the Report of the Smithsonian Institution for 1870, with an historical introduction, in print now for the next number of the *Annales Hydrographiques* of Paris.

a north-west storm passing slowly north of the city without bursting, and disappearing in the south-east. Great branched masses of cloud appeared suspended from a sheet of Pallio-Cirrus. Some resembled bunches of grapes (*a*), others stalactites (*b*) in a striking manner, and still others formed round balls (*c*) separated by the azure of the sky. These balls seemed to be formed of snow flakes, and approached the form of Cirro-Cumulus; one might say of masses of snow rolled upon themselves by the effect of electric currents developed during the storm. This was accompanied by thunder and lightning at Washington, and by lightning only at Beloit. *d* represents one of these balls detached, with two sorts of penumbra, darker in *e* and *f*, and a streak at *g*, the rest whitish. Somebody at Beloit told me he had seen this form of cloud two or three times. A slightly brilliant aurora borealis was seen at Beloit the same evening. The night of its appearance at Washington no aurora was visible, but I do not know whether there may not have been one in other parts of



the United States. The same evening and the next day at Beloit the temperature fell several degrees. It is a general belief that the aurora borealis is followed by a decrease of temperature. We know that in higher strata of the air vapour of water floats constantly in the form of frozen needles, especially in the polar regions. It is not impossible that these ice needles may be drifted by the electric current which engenders the aurora borealis* into lower latitudes, and thence towards lower strata of the atmosphere by the winds and storms. Hence the cooling of the air which is said to attend the aurora.

ANDRÉ POËY

EXOGENOUS STRUCTURES AMONGST THE STEMS OF THE COAL MEASURES

THE perusal of Dr. M'Nab's reply to my short article on the existence of an exogenous process of growth amongst the cryptogamic stems of the coal measures, confirms my previous conviction that the discussion of *the details* of my proposition can lead to no beneficial results until the publication of my large store of new facts has been completed. Dr. M'Nab's article convinces me, as indeed is necessarily the case, that he has no conception either of the nature or of the extent of those facts. Were it otherwise, he would see at a glance how far his explanations are from accounting for them. He has given an exposition of a common process of exogenous growth, which is true as far as it goes; but I can assure him that the modifications of that process, so far as we can infer from peculiarities of structure, have been much more varied in past geological ages than he is aware of. He is pleased to affirm two things which require proof: (1) that I have "been led away by the mere superficial resemblance of the parts;" and (2) that I have "never tried to understand the homologies of these stems." To the first of these charges I plead not guilty; to the second I reply that I was *trying* to understand these things when he was a child at school. Whether or not I have succeeded remains to be seen, but as yet he has told me nothing new to me.

In studying the relations of the several parts of a plant, we have to consider three things, of which Dr. M'Nab has mainly dwelt upon one. These are—

1. The relative positions of the tissues.
2. The mode of their development.
3. The functions they have to perform.

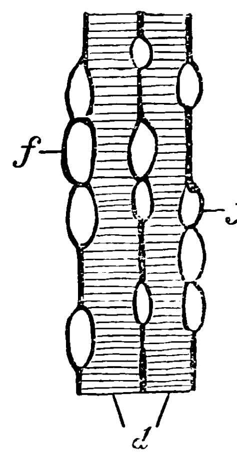


FIG. 1

The first point where I shall differ from Dr. M'Nab is in supposing that a correspondence on the first of these clauses invariably pre-supposes a similar correspondence on the second. I shall have to show on a future occasion that Nature has attained the same end in more ways than one; and that she refuses to be shut up to that dichotomous arrangement pre-supposed by Dr. M'Nab; but for the present I will limit my illustration to the particular mode of growth upon which he rests his case.

If we take a perfect Stigmaria, we find its centre (*a*, Fig. 2, p. 491) to be occupied by an axis of ordinary cellular parenchyma unmixed with any vascular tissue. This is surrounded by a ligneous or vascular cylinder (*b*) which, in its turn, is invested by a thick bark (*c*) consisting of a mixture of parenchyma and prosenchyma arranged in definite positions. The central axis differs in no respect whatever from the cellular piths of ordinary exogenous stems. The woody cylinder consists of vessels which, in the transverse section, are arranged in radiating lines (*d*) running from the pith to the bark; these lines are separated by intervening cellular tracts (*e*), which I, in common with Brongniart and Dr. Hooker, designate medullary rays. The radiating lines of vessels exhibit proofs of distinct interruptions to the process of growth, and afford clear evidence that the cylinder began as a thin ring of vessels surrounding the pith, and which grew, by successive concentric additions of vessels, to its peripheral surface where the cambium layer is found in ordinary exogens. We have here no trace of the limiting tissues of which Dr. M'Nab speaks; the growth has been free and prac-

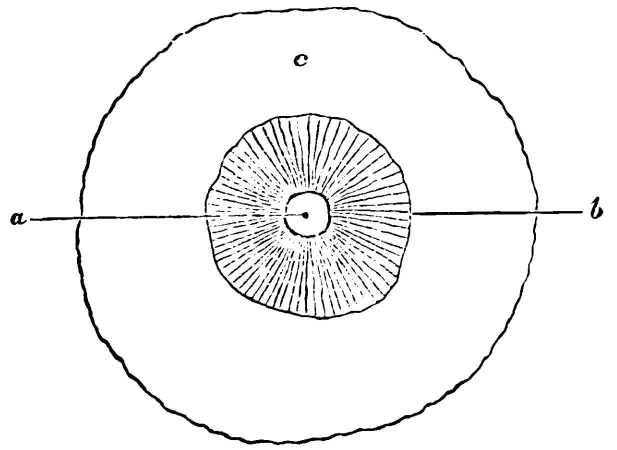
* See my Memoir on the Development of Electricity during the Aurora Borealis in the "Annuaire de la Société Météorologique de France," 1861, vol. ix. p. 42.

tically continuous, in an outward direction, by the addition of layer after layer. The materials for the new vessels have obviously been furnished by some protoplasmic element which, whether we call it cambium, or choose to give it some other name, was located at the line of junction between the wood and the bark. The additions effected by its agency have gone on through successive ages until the thin vascular cylinder became a large hard-wooded stem capable of upholding a gigantic forest tree.

If we turn to the medullary rays, we find that they consist of vertical laminæ of cells. In the tangential section they appear as vertical lines of cells (*f*, Fig. 1, p. 490), undistinguishable from those seen in the corresponding sections of most conifers. In radial sections made in the plane of the medullary rays, we find that the latter proceed continuously from the pith to the investing bark, with each of which tissues they become intimately blended at their corresponding extremities. The component cells further exhibit, in this radial section, the mural arrangement so characteristic of ordinary medullary rays. As the vascular cylinder increased in diameter by additions to its exterior, so these medullary rays became lengthened by the similar addition of new cells to their outer extremities, such cells being supplied from the same source (cambium) as the corresponding new vessels.

Now, in all these processes of growth, I re-affirm that we have nothing which can, in any plain sense of the word, be termed *Acrogenous.* I can discern no material difference between what I have just described and what occurs in a *Cycad* or in a *Conifer.* In all these cases the additions are equally made to the exterior of a gradually enlarging cylinder, new cells being added to the outer extremities of the medullary rays, and vessels to the intermediate lines of vascular tissues; the raw material for both having been furnished, as in exogens, by some protoplasmic layer located between the vascular cylinder and the bark. I do not very clearly understand what Dr. M'Nab means when he speaks of a "pseudo-exogenous" growth, or of an "increase which takes place in the wood cells of the primitive tissues, not, as in Dicotyledons, by additions to the wood-cells of the fibro-vascular bundles." I detect no such difference as he seems to imply in the example which I have given.

If I rightly understand his meaning, Dr. M'Nab considers me to affirm that in all these cryptogamic plants of the coal-measures, there has been exactly the same process of growth, corresponding in each minute detail, as takes place during the growth of an oak tree. I have never affirmed this. On the contrary, I shall have to show that, amongst these coal plants, there are indications of many remarkable combinations and varied modifications of the process of growth.



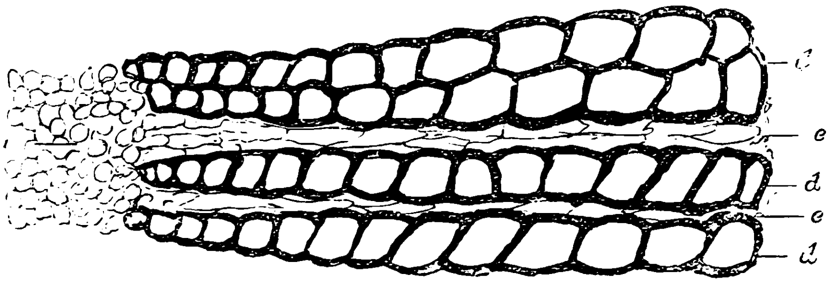


FIG. 2

Whether we do or do not accept the doctrine of evolution, we should expect to find such generalised combination amongst these primæval forms of vegetable life. I once more repeat, however, that these matters are scarcely capable of further discussion until my series of detailed memoirs has been published. When this takes place, I think Dr. M'Nab will see that I have not made the two "fatal errors" which he imagines I have done, and that there is more in my proposed classification than he, at present, has any idea of. At the same time I may remind him that the recognition of an exogenous process of growth amongst cryptogams is not now propounded for the first time. Dr. Hofmeister has given us most detailed accounts of such a process in his history of the development of Isoetes—itself a Lycopodiaceous plant. I merely propose to show that a mode of increment which now lingers in this one dwarfed genus amongst living Lycopodiaceæ, was once widely diffused, not only throughout this group of plants, but equally presented itself amongst the Calamitaceæ.

Prof. Dyer's temperate and intelligent reply to my article on the above subject resolves itself into two parts, the first of which deals with facts and the second with opinions. As to his facts he is in the same position as Dr. M'Nab. He is not acquainted with the materials for forming an opinion which I have in my hands, and upon which my views are based, consequently he has taken one extreme type of Lycopodiaceous stem, and made its supposed characters representative of the entire group. No. 129 of the Proceedings of the Royal Society which contains an abstract of my last memoir on the subject, would have shown him that I do materially differ from Mr. Carruthers in my interpretation of *Lepidodendron selaginoides*, the plant to which he refers, which difference of opinion I also expressed at the Edinburgh meeting of the British Association. I there showed that the central axis does not, as Prof. Dyer affirms, "consist wholly of scalariform vessels," but that these vessels are largely intermingled with true scalariform cells. But this is not all. The plant in question is but one of a large variety of forms. It occupies one end of a linear series of types—the opposite extremity of which series exhibits a very different aspect. The medullary vessels, which, in *Lepidodendron selaginoides*, are thus intimately commingled with the medullary cellular tissue, in the other types gradually recede from the centre to the periphery of the central cellular axis; the latter thus assuming the condition of a purely cellular parenchymatous pith, the cells of which are not even scalariform. The medullary vessels, thus driven to the periphery, now assume the position of the medullary sheath of the higher exogens. The vascular tissues for which I claim an exogenous origin are superadded to the exterior of this vascular medullary cylinder. We thus see that the central axis of these plants, instead of consisting of two parts, as Prof. Dyer affirms, really consists of three,* viz, a central cel-

* Stigmaria is an exception. In it the medullary vessels are altogether absent, as stated in my reply to Dr. M'Nab.

lular pith, an inner ring of vessels belonging to the medullary portion of the axis, and an external vascular cylinder, which grows by additions to its exterior, and which no more belongs to the central medulla than do the ordinary wood layers of an exogenous phanerogam. It has unquestionably been the product, as Prof. Dyer admits to be probable, of a cambium layer.

Speaking of the Lycopodiaceous stems of the coal measures, Prof. Dyer says, "I am inclined to think, with Prof. Williamson, that the stem increased in thickness." This point is not one to be thought about as if it was uncertain. We have in our museum accurate casts of the Dixonfold trees, and the base of the stem of the largest of these, above the point whence the huge roots are given off, is twelve feet in circumference! Higher up it is eight feet. There is surely no room for questioning an increase of thickness here, and this instance is but one example of what is sufficiently common in the coal measures. When we turn to the interior of these large trees, we find, as I have abundant evidence to prove, that they were enabled to sustain their huge bulk by an exogenous development of their outer cylinder of vessels, which were not mere modifications of the medullary vessels, but something superadded. This woody structure was amply provided with medullary rays, and each of the several layers of the thick bark increased *pari passu* with an increase of the ligneous zones, whilst a large cellular pith occupied the centre of the stem. So much for the facts, which are very different from those recognised by either of my two opponents. Now as to opinions, Prof. Dyer says he thinks that this increase was "nothing more than an incident in the life-history of a particular race of plants, nothing more than an adjustment to an arborescent habit dropped when the arborescent habit was lost." I am not sure that I understand all that Prof. Dyer means in this passage. He appears, however, to imply that these exogenous conditions were merely adventitious growths assumed for a season, and thrown off at the earliest opportunity; that they had no true affinity with the plants in which they were found. I confess I see no grounds for so remarkable a conclusion, especially remembering that, at least, these conditions lasted throughout the vast duration of the Devonian and Carboniferous ages. That one object of the exogenous growth was to enable these trees to sustain a huge superstructure, is doubtless true, though we find that growth in myriads of plants that have no such ponderous superstructures; but must we not say the same thing of the oak and the beech, as well as of the Lepidodendra? I see no difference between the cases. We have no more reason for regarding these conditions as merely an incident in the life-history of a particular race in the one instance than in the other.

I will not now discuss the value of the terms exogen and endogen, since the question has little importance in reference to the present object. I will only say that the mode of growth of a plant appears to me to have equal value with the mode of reproduction. There is a fashion in these matters—and in some circles there is now a tendency to elevate the reproductive at the expense of the vegetative, with which I do not agree, but I repeat this is not a question essentially important at present. My two great objects have been, first to demonstrate the existence of the exogenous structure in the trees in question; and second, to show the absurdity of applying the term acrogen to trees so constructed.

The value of my proposed classification is an independent question. I attach but a limited importance to the artificial boundary-lines introduced by systematisers, and do not wish to assign more to my own than to those of others; nevertheless, such divisions are useful so far as they indicate affinities, and it is because I find such affinities in the plants before us, *unrecognised by existing classifications*, that I have suggested a new one. Whatever value different minds may attach to the fact, there exists the great vegetative difference upon which I have dwelt between the Lycopodiaceæ and the Calamites on the one hand, and the Ferns on the other. There is certainly something more involved in this fact than "the old division of plants into trees and shrubs," with which Prof. Dyer compares it. Such a division is merely one of size and duration, not of organisation. Herbs, if they belong to the exogenous group, are as truly exogenous in their type as the most gigantic trees of the same class. Size has nothing to do with the matter. The same uniformity of type, apart from size, exists amongst my fossil cryptogams. True, the exogenous growth attains the fullest development amongst the large trees—but all the rudiments of this growth are equally to be found in the small ones, as my forthcoming memoirs will demonstrate.

The outer exogenous growth must be distinguished from the primitive vessels of the central medullary axis. I have yet to publish a remarkable series of facts illustrating this point. I have stated in a previous article that, in one sense, the exogenous vessels are a development of the vascular bundles of the living Lycopods. This is teleologically true rather than morphologically. Viewed in the latter aspect the two groups of vessels are independent of each other. The medullary vessels may be, and often are, primitive tissues formed at the first growth of the plant or of its young branches. The exogenous ones are something added, furnished by a cambium layer. The two groups retain their independent positions permanently, just as in living exogens the medullary sheath remains distinct from the woody cylinder which encloses it.

W. C. WILLIAMSON

NOTES

WE believe that the arrangements of the Eclipse Expedition are nearly all made, and that the numbers are now complete. The Expedition sails on Thursday next in the *Mirzapore*, arriving at Point de Galle on the 27th November, if all goes well. M. Janssen, we believe, is already *en voyage*. Prof. Respighi, of Rome, will accompany the English Expedition.

BOTH Mr. Hind and M. Stephan at Marseilles have obtained observations of Encke's comet. Mr. Hind thus writes: "It is a large, faint, and very diffused nebulosity—a different-looking object from what I remember it in one or two former returns, when it has been drawing just within reach of the telescope. The last observation on the 12th of October gives the following place:—At $9^h\ 16^m\ 18^s$ mean time at Twickenham, right ascension, $1^h\ 7^m\ 37{\cdot}8^s$; north declination, 36° 47′ 38″. The ephemeris for this appearance, published in *Mélanges Mathématiques*, of the Academy of Sciences of St. Petersburg, and calculated by Herr von Glasenapp, of the Russian National Observatory at Pulkowa, required, according to the above observation, corrections of 36 seconds in right ascension and ten minutes in declination, subtractive in both elements. The comet's positions for the next few days will be nearly as follows:—

For Midnight at Greenwich.

	R.A. h.	R.A. m.	Decl. N. Deg.	Decl. N. Min.
October 19	0	30·7	38	27
,, 21	0	17·8	38	45
,, 23	0	3·6	38	56
,, 25	23	48·3	38	59

THE Expedition to Moab, which has been organised by Dr. Ginsburg, and goes out under the auspices of the British Association, will leave England in January. Its object is to explore the geography, antiquities, and natural history of the region. Canon Tristram will accompany Dr. Ginsburg.

Bulletin Astronomique de l'Observatoire de Paris is the title of an official circular, containing meridional observations of the sun, moon, and planets, made at the National Observatory, and news as to comets, minor planets, and the like. It promises to be very useful, and it is to be wished that other observatories will follow M. Delaunay's example.

THE contract for the new telescope which Congress has authorised the National Observatory at Washington to procure has been given to Mr. Alvan Clarke, of Boston, the well-known manufacturer of astronomical apparatus. It is to be of twenty-six inches aperture, and to be completed, according to contract, in about two years. It is understood that Mr. Clarke will again visit Europe for the purpose of carefully examining the principal telescopes there before completing the one in question. He has already minutely examined Mr. Newall's 25-inch, the *chef d'œuvre* of our English opticians, Messrs. Cooke and Sons, of York.

THE College of Physical Science at Newcastle-on-Tyne is now fairly at work. Already nearly fifty students are enrolled, and more are expected. Professors Aldis, Page, Herschel, and Marreco delivered their introductory lectures to large and appreciative audiences. Each of the professors, while touching especially on his own particular branch of science, dilated on the advantages accruing from the study of physical science, not only to the student who desires a special technical education, but to the community at large. Prof. Aldis, while expressing a hope that the advantages of the College would be thrown open to women as well as to men, made the following admirable remarks on the study of mathematics by women :—"A mathematical training, by which I do not mean learning Euclid by heart, will be a good preparation for the study of political economy and for the study of nature ; I think not a bad preparation for the proper management of a house, and the mother's duties towards her children. I am sure that the time spent in receiving such a training, even if by getting it a lad or a lass be obliged to commence active duties a year or two later, will be time well spent, and will give an impetus which will carry them both through life with an ease which scarcely anything else will afford." We understand that Professors Herschel and Marreco intend that physical and physico chemical measurements shall be practised by the students, although there is yet no physical laboratory. At the time of going to press the question of admitting ladies had not been decided. A fair start seems to have been made, and we can only wish the new college as prosperous a future.

TRINITY College, Cambridge, has, it appears, the power of electing to its Fellowships men of scientific or literary distinction, and we are extremely glad to learn that Dr. Michael Foster has been thus elected. Dr. Foster was recently appointed to the newly-created post of Prælector in Physiology at the College, and this election to a further share of the emoluments and administration of the College proves that the members of the foundation are determined to carry out their intentions of promoting the study of Physiology in Cambridge. A temporary laboratory has been fitted up in the New Museums of the University, in which Dr. Foster gives lectures, and conducts the practical teaching. At the same time Mr. Hopkinson, Senior Wrangler of 1871, was elected a Fellow of Trinity College. These elections are the first-fruits of the act of last session admitting Nonconformists to a full share of the benefits of the University.

MR. WALTER WILLIAM FISHER, B.A., was on Saturday elected to an open Natural Science Fellowship at Corpus Christi College, Oxford, the examiners for which, Dr. Odling and Mr. A. Vernon Harcourt, made honourable mention of Mr. Christopher Childs, Scholar of Merton College. Mr. Fisher entered at Worcester College, from whence he gained a Natural Science Postmastership at Merton College, and was placed in the first class in the Natural Science Schools in Trinity Term 1870.

MR. MOSCARDI, from the Somersetshire College, Bath, has been elected to a Mathematical Scholarship at Worcester College, Oxford, on the Finney Foundation, open *pro hac vice;* and Mr. White, from the Liverpool Institute, has been also elected an Exhibitioner.

IT is gratifying to learn that Her Majesty has conferred the honour of Civil Companion of the Bath on Mr. J. H. Parker, the distinguished antiquarian. It is not often that we find either Science or Art so highly recognised in England ; but is the Companionship of the Bath the fittest reward we have to bestow on scientific merit ?

THE forty-fourth annual meeting of the Association of German Naturalists and Physicians has lately been held in Rostock. It has entered on the fiftieth year of its existence, having been founded in 1822 by Oken, who brought together twenty-one naturalists in Leipzig. Since that time a meeting has been held each year, with five exceptions. In 1831 and 1832 the meetings were suspended on account of the prevalence of cholera ; in 1848, on account of political disturbances ; and in 1867 and 1870 on account of war. The *British Medical Journal* states that the recent meeting was not so numerously attended as usual, many of the members having probably been detained at their homes through a fear of their professional services being required on account of the occurrence of cholera. One of the principal features of the meeting was an eloquent address by Prof. Virchow, on the position and prospects of natural science in the new national life of Germany.

SEVERAL friends of the Saturday half-holiday movement in London have offered the sum of thirty guineas for competition to London field-naturalists and microscopists for the encouragement of Saturday afternoon field excursions for botanical, geological, and microscopical purposes. The Duchess of Sutherland offers ten guineas to botanists in three prizes for the best collection of mosses, including the Hepaticæ, obtained within twenty miles of London ; the Countess of Ducie ten guineas to microscopists in three prizes for the best lists of the ponds and other aquatic resorts within fifteen miles of London, and the Microzoa found in them ; and the Marquis of Westminster ten guineas to geologists in two prizes for the best list of open geological sections and exposures of the strata of the London district, giving the fossil species found in each section, and the characteristic species of each formation exposed, and for the best notes on the connection of the landscape scenery of the London district with its geology. This movement is an admirable one, and altogether to be commended. Professional collectors and dealers are wisely excluded from the competition, the prizes being intended exclusively for those with whom natural history pursuits are solely the recreation of their leisure after-business hours.

THE *Athenæum* states that Prof. Owen has written to the Mayor of Brighton, "on the subject of a survey of the Sussex Wealden deposits, the district made famous by the discoveries of Mantell." Any efforts made by Brighton to get together between the present date and August 1872, the date of the meeting of the British Association, a collection illustrative of the Iguanodon and other extinct animals, would be esteemed a favour, and would be appreciated by members and visitors. Prof. Owen recommends Mr. E. Charlesworth as peculiarly qualified for carrying out the scheme of the authorities, and benefiting permanently the Brighton Museum. After a recent meeting of the Town Reception Committee, Mr. Charlesworth addressed a few of the members of the Committee on the Weald deposits ; but the town authorities have no power under existing Acts of Parliament to levy rates for palæontological researches.

THE Coventry Institute has arranged for a complete course of Science Classes in connection with the Department of Science and Art through the approaching winter, in inorganic chemistry, animal physiology, magnetism and electricity, physical geography, and mathematics. We are particularly glad to see that they are arranged for young persons and adults of both sexes.

IN reference to the threatened destruction of what still remains of the Druidical Temple at Avebury, a correspondent of the *Times* states that negotiations are in progress for the purchase of the land intended to have been sold for building allotments, so that the remains of this fine old temple shall remain in their present state.

PROF. PHILLIPS's so much looked-for work on the Geology of the Thames Valley is announced for publication. The Professor proposes to make it his text-book for a course of lectures on Oxford Geology, to be delivered this term at Oxford.

A SEVERE earthquake shock was felt at Callao and other places on the coast on August 21. The direction of the undulations was from N.W. to S.E., and the shocks lasted for fifteen seconds. Cero Azul and Pisco also suffered from the same shock.

ON Sunday the 8th of this month, a violent earthquake shock was felt at Pera and Constantinople. The motion lasted for about five seconds. No great amount of damage was done.

THE terrible fire at Chicago, which raged during the early part of last week, and of which the ravages far exceed those of the Great Fire of London, affords us an additional example from which to judge of the truth of the so-much-disputed assertion, that extensive fires are almost invariably followed by heavy downpours of rain, which have been caused by them. In this case the latest telegrams assure us that the fire was chiefly checked on the third and fourth days by the heavy and continuous downpour of rain, which it is conjecture was partly due to the great atmospheric disturbances which such an extensive fire would cause, especially when we are told that the season just previous to the outbreak of the fire had been particularly dry.

THE Association formed in California for the purpose of introducing Eastern fish into the waters of that State has received a first instalment in 15,000 young shad, hatched in the Hudson River just a week before, and brought in large tin cans filled to the shoulder with fresh water. They proved to be in excellent condition on their arrival on the Sacramento, and were taken thence higher up the river to Tehama, where it was proposed to plant them. The expenses of this enterprise are borne from an appropriation on the part of the State of 5,000 dollars for this special purpose.

A VERY remarkable collection of medicinal and other drugs has been brought together in the Exhibition of Natural Industry of the United States of Columbia or New Granada in the City of Bogota. Among febrifuges it includes the yellow quina of Zaragoza and the Sarpolata, which is considered more effective even than quina of dye plants. It is observed that Mr. P. M. Gonsalez has produced three shades of green from plants discovered by him in Antioquia. The Achivilla of that province produces golden yellow, the Bruja a splendid red, the Ojo Venado an intense black, and the plant of the Sagus a blue equal to indigo.

THERE is in the Museum at Cassel a curious collection illustrating European and other trees. It is in the form of a library, in which the back of each volume is furnished by the bark of some particular tree, the sides are made of perfect wood, the top of young wood, and the bottom of old. When opened the book is found to be a box, containing either wax models or actual specimens of the flower, fruit, and leaves of the tree.

THE *New York Times* states that a solid section cut from one of the original "big trees" of California is in New York on its way to a European Museum. Five men were employed twenty-five days in felling this huge tree; its height is 302 ft., and its largest diameter 32 ft. The specimen was cut at a distance of 20 ft. from the base. The stump is covered in, and is now used as a ball-room! It has been ascertained from counting the annular rings that the tree is more than 2,500 years old.

A CORRESPONDENT of the *Stationer* announces a new fibrous plant for paper-making purposes, the *Cineraria maritima*, or sea rag-wort. Several very satisfactory results have been received from various paper-makers as to its great utility for trade purpeses, and there is every reason to believe, if proper attention is paid to its cultivation, it will in time become a staple article of commerce amongst manufacturers. The seed, at present, is imported from France and the south of Europe, but preparations are being made for growing it on a large scale in this country. The same journal, in an article on "Iron-paper-making," gives a history of the manufacture of the thinnest sheet of iron ever rolled, manufactured by Messrs. W. Hallam and Co., of the Upper Forest Tin Works, near Swansea. The sheet in question is 10in. by 5½in., or 55in. in surface, and weighs but 20 grains, which being brought to the standard of 8in. by 5½in., or 44 surface inches, is but 16 grains, or 30 per cent. less than any previous effort, and requires at least 4,800 to make 1in. in thickness.

IT is stated that tobacco in any form may be used with great advantage against snakes of all kinds. By pouring a decoction of it in suspected places, they are driven away, and this fact is known to both the natives of Hindostan and to those of North and South America. If it can be administered to them it is certain death.

IN his "Contributions towards the Materia Medica and Natural History of China," Mr. Frederick P. Smith records the following facts respecting the use of Fungi as food in the Celestial Empire:—Large quantities of Fungi are eaten by the Chinese of every province under the name of *Hiang-kw'an*, and have some medicinal or dietetic properties assigned to them. The Polypori, or Boleti, are generally preferred to the Agarics, so largely eaten in Europe. *Kwei-k'ai*, or *Ti-k'ai*, are edible Agarics, or Helvellæ, and perhaps include poisonous sorts. They are burnt and applied to swellings and sores. *Ti-rh* is probably an Agaric, said to be tonic in its effects. The *Muh-rh* are a numerous class of parasitic fungi growing on trees. They are much eaten. They come from Ching-ting fu in Peh-chihli, Shun-king fu and Sui-ting fu in Szch'uen, Li-p'ing fu in Kweichau, Yun-yang fu in Hupeh, and from Shang chau and Han-chung fu in Shen si. Manchuria and the Amur country supply a portion of this food. The *Shih-rh* is a Polyporus brought from Fung-t'ien fu in Shingking, Hwui-chau fu in Nganhwui, Nan-kang fu in Kiang-si, and from Lai chau in Hunan. *T'u-k'o'an*, or *Ti-tan*, are Agarics or Amanitas, or answer to the "toad-stools" and other injurious fungi. Some of them are said to cause irrepressible laughter. Alum and chicory are reported to be antidotal to their poison. Japanese mushrooms appear in the tariff as *Tung yang-hiang-ku*.

MUCH interest was excited in the scientific journals some time ago by the accounts given in the Panama papers of the flights of a beautiful butterfly, the *Urania leilus*. By late advices from Panama we learn that these insects were passing over that city, from west to east, in July last, in very large numbers, and in some cases were attracted into houses by the light so as to almost fill the apartments. They are said to be accompanied during the day by swallows and swifts, and in the night by the different species of goat-sucker, which probably destroy large numbers. Nothing is at present known, however, of the place whence they came, nor the region to which they are ultimately bound.

SCIENTIFIC INTELLIGENCE FROM AMERICA *

SOME of our readers are probably aware of the important archæological discoveries made a few years ago in the island of Cyprus by Mr. L. Di Cesnola, United States consul at that island, and of the interest which they excited throughout the civilised world. This consisted in the finding of a buried city, and of numerous graves of the ancient Phœnicians and other early races of the island of Cyprus, previously entirely unknown. Excavations were prosecuted by him at great expense, and resulted in the accumulation of an enormous mass of treasures of art of gold, silver, bronze, pottery, &c. Various government authorities and public museums of Europe have, it is understood, opened negotiations for the acquisition of the entire collection, and it was stated that an offer had been made from Boston for their purchase; but nothing definite appears to have been accomplished. It is said that of the various offers, one on the part of the French Government was most satisfactory, but that the consummation of the purchase was prevented by the late war. The value of these treasures will be shown by the following enumeration of the specimens of the collection, especially when we bear in mind that many of them are most exquisite specimens of art, and all are of undoubted authenticity and great antiquity:—

Antique Greek, Phœnician, and Roman glass-ware unguentaries, bottles, bracelets, tear-bottles . . .	1200
Phœnician, Assyrian, Egyptian, and Greek vases from three feet in height to two inches	4000
Greek and Roman and Byzantine lamps, with and without bas-reliefs and inscriptions	1400
Bronzes of every kind, strigiles, pateras, fibulas, speculas, spear-heads, &c.	420
Phœnician, Greek, and Cypriote (?) inscriptions . .	96
Stone statues of every size (Temple of Venus) . .	204
Stone heads of every size (Temple of Venus) . . .	790
Terra-cotta statuettes, votive offerings, &c., . . .	320
Gold objects, cylinders, scarabees, &c., ...	130
	8560

These were obtained by excavating at least 8,000 graves, and from the Temple of Venus at Golgos, the discovery of which by Mr. Cesnola was scarcely inferior in archæological importance to that of ancient Nineveh by Mr. Layard. In this were found numerous inscriptions in an unknown Semitic language (Cypriote?). —In previous numbers we have given an account of certain deep-water explorations in the great lakes, which resulted in the detection of species of crustaceans and of fishes new to science, and belonging to marine rather than to fresh-water types. This, of course, does not prove the occurrence of other marine conditions at the bottom of the lakes, such as salinity of the water, &c., although it may perhaps excite a suspicion to that effect. Additional researches have been prosecuted during the present season in this direction, two parties being engaged in them—namely, Mr. James W. Milner, of Waukegan, and Mr. Sidney J. Smith, of Yale College, the former working principally in Lake Michigan, and the latter under the auspices of the Engineer Department, in Lake Superior. Both these gentlemen have carried on their labours at depths exceeding 100 fathoms, and have determined the existence of various novel forms of animal life, of which due mention will be made hereafter.—Professor J. D. Whitney, in a recent communication to the Academy of Sciences of San Francisco upon the use of the barometer in determining altitudes, remarked upon the effect which temperature exerts upon the instrument, and stated that the difference between the cold of winter and the heat of summer would sometimes, in the same instrument, involve a difference in the estimate of a given height of as much as seventeen feet. He hoped in time to have tables prepared which should give the allowances that must be made for each day of the year, and for different times in the day, an observation at 9 A.M. sometimes giving a different result from one taken at 2 P.M. at the same altitude on the same day. He also expressed his dissatisfaction with the aneroid barometer as a means of measuring altitudes, although he had experimented with the best that were offered in the market. He found them reliable for a certain time only, and they appeared to have spells of irregularity from which they recovered very slowly. He did not find any upon which he could rely for heights above 1,000 feet.—From the *Alaska Herald* we learn that M. Alphonse Pinart had reached Nushigak on the 31st of May, where he was received very cordially by the authorities. While there he made numerous photographic pictures of the scenery, and gathered collections in ethnology and palæontology. He left Nushigak on the 16th of June, on board the steamer *John Bright*, for the Yukon River, and expected to reach the interior in time to attend the great July fair held by the Yukon Indians.

* Communicated by the Scientific Editor of *Harper's Weekly*.

PROF. HUXLEY ON THE DUTIES OF THE STATE

WE are able to give the following extracts from Prof. Huxley's address at Birmingham, to which we alluded last week:—The higher the state of civilisation the more completely did and must the action of one member of the social body influence all the rest, and the less possible was it for any one man to do a wrong thing without interfering more or less with the freedom of all his fellow-citizens. So that, even in its narrowest views, the functions of the State, it must be admitted, should have a wider power than even those who, without this doctrine of administration, were willing to admit. It was urged, he was aware, that if the right of the State was conceded to assign limits at all, there would be no stopping it, and that the principles which justified the State in enforcing vaccination and education also justify it in prescribing his religious belief, and mode of carrying on his trade or profession, or in determining the number of courses he should have for his dinner, or the pattern of his waistcoat. But surely the answer was obvious, that on similar grounds the right of a man to eat when hungry might be disputed, because if he were allowed to eat at all he must be allowed to use that faculty which told him he must not surfeit himself. But in practice every one knew that a man left off when reason told him that he had had enough. And so, properly argued, the State, or governing body, would find out when reason was carried far enough. But so far as his acquaintance with those who carried on the business of Government went, it was that they were far less eager to interfere with the people while the people were keenly sensitive. He could not discover that Locke affected to put the doctrine of modern liberation—that the toleration of error was a good thing in itself, to be reckoned amongst the cardinal virtues; on the contrary, he was strongly opposed to this, and he laid it down that whenever it was necessary for the preservation of civil society that toleration should be withdrawn it ought to be withdrawn. . . . There must be strong and cogent reasons for legislation on abstract matters, before the governing body entered upon such a course of legislative action as that of which he had spoken, and which might tend towards that state contemplated by the champions of Nihilism. He then quoted the doctrine laid down by Mr. Herbert Spencer, to the effect that the relations of political bodies bore a strong resemblance to vertebrate animals in their organisation, and that as the brain was the guiding power of the animal, so in communities the Government answered the same purpose. . . . . . In fact, much of our social relations were based upon this simple law—that one man established his right to the one thing, and in another direction to abstain from doing another thing. In many cases government degenerated, and became a recognised system for effecting fraud and plunder; but wherever sound social relationships existed between different members composing the social life of a country, this was impossible. But to reach this every man, and the aggregation of men in communities, limited their independence. He next spoke on individual responsibility, and said that it was the duty of the individual to protect society; if the individual breaks all bonds, then society perishes. The welfare of the social organisation depended not only on the brain, or the government, but on the members; but unquestionably a good deal depended on what the functions of the Government were. This touched at the root of social organism, and the problem which had presented itself to many minds was one not easy to solve. John Locke had furnished them with an answer which for a time sets the matter at rest. The end of a Government is the good of mankind. The good of mankind was not something which was an absolute fixed thing for all men, whatever their capacities. It was possible to maintain the individual freedom, and promote the higher functions that the government has translated into another sphere; but what ought we men in our corporate capacity to do in the way of restraining the free individual in that which was contrary to the existence of nature? John Locke had furnished them with the solution—true *civitas Dei*—in which every man's faculty was such as to allow him to control all those desires which ran counter to the good of mankind, and cherish those only which would benefit the welfare of the whole of society, and which every man felt as sufficiently true to enable him to know what he ought to do. Society as now constituted consisted of a considerable number of the foolish and the ignorant—a small proportion of good genuine knaves and a sprinkling of capable and honest men, by whose efforts the former were kept in a reasonable restraint. Such being the case, he could not see how the limit could be laid down as to the question which, under some circumstances, the action of Government might be rightfully carried on, The question was where they ought to draw the line between those things which a State ought to do, and which they ought not to do. The difficulty which met the statesmen was the same as that which met all of them in individual life. Moore and Owen, and all the great modern Socialists, bear witness that Government might attain its end for the good of the people by some more effectual process than the very simple and easy one of letting all matters of enterprise alone. He thought that the science of politics was but imperfectly known; and that perhaps they would be able to get clearer notions of what a State might or might not do, if they estimated the truth of the proposition, that the end of government is the good of mankind. It was necessary to consider a little what the good of mankind really was. The good of mankind meant the admission of every man to all the happiness which he could enjoy without diminishing the happiness of his fellow men. Having dwelt at some length on this point, Mr. Huxley went on to say that it was universally agreed that it would be useless to admit the freedom of sympathy between man and man directly; but he could see no reason why the State might not do many things towards that end indirectly. He was not going to argue that there should be a State science, or a State organisation, such as they had seen in France, by which all scientific teaching was to be properly regulated. On the contrary, the State had left local enterprise to work out its own ends as soon as local intelligence and energy proved itself equal to the task. These local efforts not only benefited the localities; but every means of teaching, every stimulus given to intellectual life was so much positively added to the wealth and welfare of the nation, and as such deserved some equivalent modicum of support from the general purse. But if the positive advancement of the peace, wealth, and intellectual and moral development of its members were the objects which the representative of the corporate authority of society, the Government, might justly strive after in the fulfilment of its end, which was the good of mankind, then it was clear that the Government might undertake the education of the people, for education promoted peace by teaching men the realities of life, and the obligations which were involved in the very existence of society; and promoted the intellectual development, not only by training the individual intellect, but by sifting out from the mass of ordinary or inferior capacities those which were competent to increase the general welfare by occupying higher positions; and lastly, it promoted morality and refinement by teaching men to discipline themselves, and leading them to see that the highest, as it was the only permanent, content was to be attained not by groveling in the rank stream of the foulest sense, but by continually striving towards those higher peaks where, resting in eternal calm, reason discerned the undefined but bright ideal of the highest good, "a cloud by day, a pillar of fire by night."

ON THE STRUCTURE OF THE PALÆOZOIC CRINOIDS *

THE best known living representatives of the Echinoderm class Crinoidea are the genera *Antedon* and *Pentacrinus*—the former the feather stars, tolerably common in all seas; the latter the stalked sea-lilies, whose only ascertained habitat, until lately, was the deeper portion of the sea of the Antilles, whence they were rarely recovered by being accidentally entangled on fishing-lines. Within the last few years Mr. Robert Damon, the well-known dealer in natural history objects in Weymouth, has procured a considerable number of specimens of the two West Indian *Pentacrini*, and Dr. Carpenter and the author had an opportunity of making very detailed observations both on the hard and the soft parts. These observations will shortly be published.

The genera *Antedon* and *Pentacrinus* resemble one another in all essential particulars of internal structure. The great distinction between them is, that while *Antedon* swims freely in the water, and anchors itself at will by means of a set of "dorsal cirri," *Pentacrinus* is attached to a jointed stem, which is either permanently fixed to some foreign body, or, as in the case of a fine species procured off the coast of Portugal during the cruise of the *Porcupine* in the summer of 1870, loosely rooted by a whorl of terminal cirri in soft mud. Setting aside the stalk, in *Antedon* and *Pentacrinus* the body consists of a rounded central disc and ten or more pinnated arms. A ciliated groove runs along the "oral" or "ventral" surface of the pinnules and arms, and these tributary brachial grooves gradually coalescing, terminate in five radial grooves, which end in an oral opening, usually subcentral, sometimes very excentric. The œsophagus, stomach, and intestine coil round a central axis, formed of dense connective tissue, apparently continuous with the stroma of the ovary, and of involutions of the perivisceral membrane; and the intestine ends in an anal tube, which opens excentrically in one of the inter-radial spaces, and usually projects considerably above the surface of the disc. The contents of the stomach are found uniformly to consist of a pulp composed of particles of organic matter, the shields of diatoms, and the shells of minute foraminifera. The mode of nutrition may be readily observed in *Antedon*, which will live for months in a tank. The animal rests attached by its dorsal cirri, with its arms expanded like the petals of a full-blown flower. A current of sea water, bearing organic particles, is carried by the cilia along the brachial grooves into the mouth, the water is exhausted of its assimilable matter in the alimentary canal, and is finally ejected at the anal orifice. The length and direction of the anal tube prevent the exhausted water and the fœcal matter from returning at once into the ciliated passages.

In the probably extinct family Cyathocrinidæ, and notably in the genus *Cyathocrinus*, which the author took as the type of the Palæozoic group, the so-called Crinoidea Tessellata, the arrangement, up to a certain point, is much the same. There is a widely-expanded crown of branching arms, deeply grooved, which doubtless performed the same functions as the grooved arms of *Pentacrinus*; but the grooves stop short at the edge of the disc, and there is no central opening, the only visible apertures being a tube, sometimes of extreme length, rising from the surface of the disc in one of the inter-radial spaces, which is usually greatly enlarged for its accommodation by the intercalation of additional perisomatic plates, and a small tunnel-like opening through the perisom of the edge of the disc opposite the base of each of the arms, in continuation of the groove of the arm. The functions of these openings, and the mode of nutrition of the crinoid having this structure, have been the subject of much controversy.

The author had lately had an opportunity of examining some very remarkable specimens of *Cyathocrinus arthriticus*, procured by Mr. Charles Ketley from the upper Silurians of Wenlock, and a number of wonderfully perfect examples of species of the genera *Actinocrinus*, *Platycrinus*, and others, for which he was indebted to the liberality of Mr. Charles Wachsmuth, of Burlington, Ohio, and Mr. Sidney Lyon, of Jeffersonville, Indiana; and he had also had the advantage of studying photographs of plates, showing the internal structure of fossil crinoids, about to be published by Messrs. Meek and Worthen, State Geologists for Illinois. A careful examination of all these, taken in connection with the description by Prof. Lovén, of *Hyponome Sarsii*, a recent crinoid lately procured from Torres Strait, had led him to the following general conclusions.

In accordance with the views of Dr. Schultze, Dr. Lütken, and Messrs. Meek and Worthen, he regarded the proboscis of the tesselated crinoids as the anal tube, corresponding in every respect with the anal tube in *Antedon* and *Pentacrinus*, and he maintained the opinion which he formerly published (Edin. New Phil. Jour. Jan. 1861), that the valvular "pyramid" of the Cystideans is also the anus. The true mouth in the tesselated crinoids is an internal opening vaulted over by the plates of the perisom, and situated in the axis of the radial system more or less in advance of the anal tube, in the position assigned by Mr. Billings to his "ambulacral opening." Five, ten, or more openings round the edge of the disc lead into channels continuous with the grooves on the ventral surface of the arms, either covered over like the mouth by perisomatic plates, the inner surface of which they more or less impress, and supported beneath by chains

* Abstract of a paper read before the Royal Society of Edinburgh, by Prof. Wyville Thomson, April 3, 1871.

of ossicles ; or, in rare cases (*Amphoracrinus*), tunnelled in the substance of the greatly thickened walls of the vault. These internal passages, usually reduced in number to five by uniting with one another, pass into the internal mouth, into which they doubtless lead the current from the ciliated brachial grooves.

In connection with different species of *Platyceras* with various crinoids, over whose anal openings they fix themselves, moulding the edges of their shells to the form of shell of the crinoid, is a case of "commensalism," in which the mollusc takes advantage for nutrition and respiration of the current passing through the alimentary canal of the echinoderm. *Hyponome Sarsii* appears, from Prof. Lovén's description, to be a true crinoid, closely allied to *Antedon*, and does not seem in any way to resemble the Cystideans. It has, however, precisely the same arrangement as to its internal radial vessels and mouth which we find in the older crinoids. It bears the same structural relation to *Antedon* which *Extracrinus* bears to *Pentacrinus*.

Some examples of different tesselated crinoids from the Burlington limestone, most of them procured by Mr. Wachsmuth, and described by Messrs. Meek and Worthen, show a very remarkable convoluted plate, somewhat in form like the shell of a *Scaphander*, placed vertically in the centre of the cup, in the position occupied by the fibrous axis or columella in *Pentacrinus* and *Antedon*. Mr. Billings, the distinguished palæontologist to the Survey of Canada, in a very valuable paper on the structure of the Crinoidea, Cystidea, and Blastoidea (*Silliman's Journal*, January 1870), advocates the view that the plate is connected with the apparatus of respiration, and that it is homologous with the pectinated rhombs of Cystideans, the tube apparatus of Pentremites, and the sand-canal of Asterids. Messrs. Meek and Worthen and Dr. Lütken, on the other hand, regard it as associated in some way with the alimentary canal and the function of nutrition.

The author strongly supported the latter opinion. The perivisceral membrane in *Antedon* and *Pentacrinus* already alluded to, which lines the whole calyx, and whose involutions, supporting the coils of the alimentary canal, contribute to the formation of the central columella, is crowded with miliary grains and small plates of carbonate of line ; and a very slight modification would convert the whole into a delicate fenestrated calcareous plate. Some of the specimens in Mr. Wachsmuth's collection show the open reticulated tissue of the central coil continuous over the whole of the interior of the calyx, and rising on the walls of the vault, thus following almost exactly the course of the perivisceral membrane in the recent forms. In all likelihood, therefore, the internal calcareous network in the crinoids, whether rising into a convoluted plate or lining the cavity of the crinoid head, is simply a calcified condition of the perivisceral sac.

The author was inclined to agree with Mr. Rofe and Mr. Billings in attributing the functions of respiration to the pectinated rhombs of the Cystideans and the tube apparatus of the Blastoids. He did not see, however, that any equivalent arrangement was either necessary or probable in the crinoids with expanded arms, in which the provisions for respiration, in the form of tubular tentacles and respiratory films and lobes over the whole extent of the arms and pinnules, are so elaborate and complete.

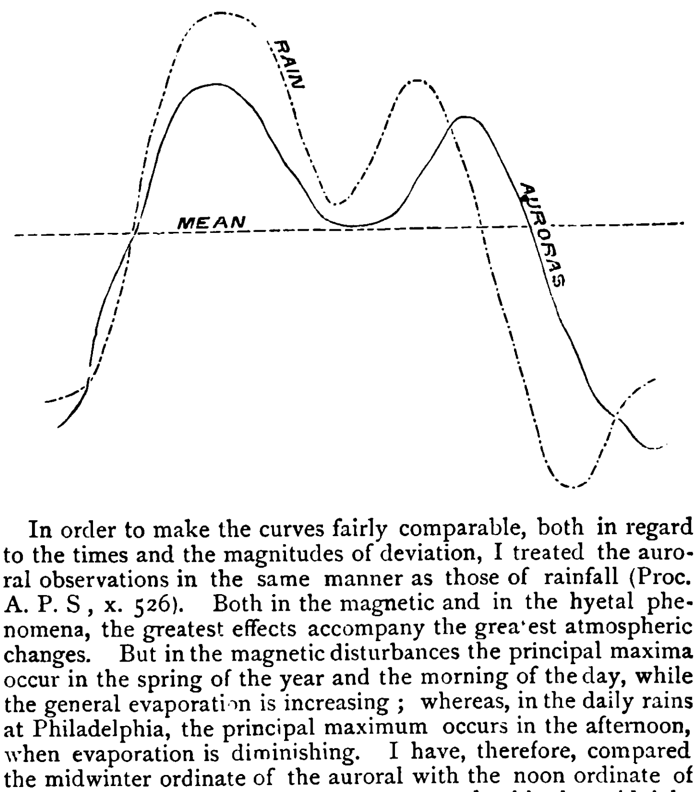
ON THE RELATION OF AURORAS TO GRAVITATING CURRENTS*

PROF. LOOMIS'S observations of the number of Auroras in each month of 1869 and 1870 (*American Journal of Science*, 3rd S., i. 309) are specially noteworthy, both because of the careful accuracy of the observer, and because they are the first published observations which furnish satisfactory data for an approximate determination of the laws of auroral distribution.

If the auroras are, as is now generally believed, luminous manifestations of terrestrial magnetism, it seems reasonable to look to them for some additional evidence upon the question of the relation between magnetic and gravitating currents. Messrs. Baxendeli and Bloxam have already pointed out some resemblances between hyetal and magnetic curves (see Proc. A. P. S., x. 368) and if analogous resemblances can be traced between hyetal and auroral curves, they will be interesting and suggestive.

I have not found the similarity between the annual distribution of rainfalls and auroras sufficiently striking to impress any one who has not made a special study of the causes of resemblance and difference. But, as I have repeatedly urged, currents are subject to an increased number of disguising disturbances, in proportion to the sluggishness of their motion, and the time which is consequently required for their formation and change. We may very reasonably look for analogies between the daily and the annual auroral or magnetic curves, of a character for which we could hope to find no parallel in wind, rain, or ocean current curves.

If we desire, therefore, to find evidence of the joint influence of solar expansion and gravitating equilibrium, we should look where it is most likely to be found, and to the best of the observations which may be supposed to be fairly comparable. There are similar variations of solar attitude, and consequently increasing and diminishing solar force, in the day and in the year, but the effects of these variations upon the precipitation of vapour are more likely to be shown in their greatest simplicity by the means of observations at different hours of the day than at different seasons of the year. I know of no published observations of this character at New Haven, but there are some extending over a long series of years at Philadelphia and at Greenwich, the curves at each station indicating minima of rainfall at noon and midnight, and maxima in the morning and evening. The difference of longitude between Philadelphia and New Haven being less than $2\frac{1}{2}^{\circ}$, it is not likely that there is any material difference in the daily rain-curves at the two places.



In order to make the curves fairly comparable, both in regard to the times and the magnitudes of deviation, I treated the auroral observations in the same manner as those of rainfall (Proc. A. P. S, x. 526). Both in the magnetic and in the hyetal phenomena, the greatest effects accompany the greatest atmospheric changes. But in the magnetic disturbances the principal maxima occur in the spring of the year and the morning of the day, while the general evaporation is increasing ; whereas, in the daily rains at Philadelphia, the principal maximum occurs in the afternoon, when evaporation is diminishing. I have, therefore, compared the midwinter ordinate of the auroral with the noon ordinate of the rain curve, and the midsummer auroral with the midnight hyetal ordinate.

The auroral observations and the normal ordinates of the accompanying curves are given in the following table. I presume no one will doubt that the condensation of vapour, which is represented by the rain-curve, is occasioned by the simple operation of gravitation in blending currents of different temperatures, and I see no reason for postulating any different law for the development of electricity and magnetism in the aurora.

Comparative Table of Auroras and Rainfalls

Month.	No. of Aurorals.	Normals.	Hours.	Normals of Rain.
		88	0	91
January . .	32	90	1	91
		94	2	93
February . .	31	98	3	98
		103	4	105
March . . .	41	107	5	110
		109	6	113
April . . .	44	109	7	113
		108	8	112

* Read before the American Philosophical Society, May 5, 1871, by Pliny Earle Chase.

Month.	No. of Aurorals.	Normals.	Hours.	Normals of Rain.
May . . .	36	106	9	109
		103	10	105
June . . .	31	101	11	102
		100	12	103
July . . .	38	101	13	106
		103	14	109
August . .	34	105	15	108
		107	16	104
September . .	43	106	17	98
		103	18	92
October . .	38	100	19	87
		95	20	85
November . .	27	91	21	87
		89	22	90
December . .	30	87	23	91

SCIENTIFIC SERIALS

Jahrbuch der kaiserlich-königlichen geologischen Reichsanstalt. Vol. xvi. No. 1. (Vienna.) The first paper in this part of the *Jahrbuch* is one by Prof. Kreuz, "Das Vihorlat-Gutin-Trachytgebirge." This is one of those painstaking lithological papers which are less commonly met with in our own scientific journals than one could wish. The author has carefully examined under the microscope the trachytic rocks of the Vihorlat-Gutin mountains of North-eastern Hungary, a range which stretches from north-west to south-east in the same direction as the Carpathian Sandstones. He groups the rocks under three divisions:—(1) Augite-andesite; (2) Sanidine-oligoclase-trachyte; (3) Breccias and Tuffs; and his descriptions of the two former are particularly full and interesting. The breccias and tuffs are necessarily less susceptible of clear concise description; they appear to vary as much and in as short a space as similar volcanic accumulations elsewhere.—Prof. Koch, of Ofen, contributes "Beitrag zur Kentniss der geognostischen Beschaffenheit des Urdniker Gebirges," an isolated little mountain range, which stretches between the Danube and the Save in East Sclavonia. He describes the Tertiary strata he examined in his last visit to that district as being grouped round the foot of the hills. The beds are of marine, fresh, and brackish-water origin. He does not determine their exact geological horizon, but gives lists of the fossils he obtained. The paper concludes with an account of a mass of sanidine-trachyte, which the author believes to be of Tertiary age.—A paper on *Aulococeras Fr. V. Hauer*, by Dr. Edm. von Mosjsisores, is illustrated with four lithographic plates. This and the following paper "On the Tertiary Formation of the Vienna Basin," by Theodor Fuchs and Felix Karrer we recommend to the attention of our palæontologists. Fuchs' and Karrer's paper is most elaborate, and contains copious lists of fossils which, besides being interesting in themselves, are useful for purposes of comparison. The *Jahrbuch* concludes with "Studien aus dem Salinargebiete Siebenbürgens," by F. Posepny; this, however, is only the second part of the paper, the first part having been published so far back as 1867. These saliferous regions are described in considerable detail, and numerous chemical analyses are given. A map, and sections. &c., accompany the paper. We should mention that the *Jahrbuch* includes obituary notices of two former members of the Institute, the well-known Wilhelm Haidinger, and Urban Schloenbach, an enthusiastic palæontologist and geologist who was cut off at the early age of thirty-one.

THE three numbers of the *Quarterly Journal of Microscopical Science* of the present year contain a number of valuable original contributions to science, besides transactions, chronicles of the progress of histology and micro-zoology, and various reviews and short notes and memoranda. In the January number Prof. Allman describes a new mode of reproduction by fission in a new hydroid polyp, which he figures in a plate.—Haeckel's researches on the nature of Coccoliths and Bathybius are noticed at length, and the remarkable Radiolarian *Myxobrachia* is figured in a tinted plate.—Mr. Archer, of Dublin, to whose researches published in the same journal in 1869 we owe our knowledge of a most beautiful and interesting group of fresh water Protista—the Heliozoa—contributes to the April number a further account of new fresh water rhizopods, illustrated with two coloured plates.—In the same number Mr. Moseley figures and describes the nerves of the cornea, and Mr. Lankester gives a minute account of the structure and mode of formation of the sperm-ropes of the river Annelids.—In the July number an exceedingly valuable memoir by Dr. Van Beneden appears "On the Development of a Species of Gregarina," which he described last year (also in the Journal). It appears that the Gregarinæ exhibit a young stage when they are devoid of nucleus, and have great activity and worm-like form; to this stage Dr. Van Beneden applies the name *pseudo-filarian.*—In the same number Mr. Sorby gives an elaborate paper on the colouring matters of leaves, which has an appropriate place in a journal devoted to microscopy, since it is only by the micro-spectroscope that many of those colouring matters can be studied on account of their small quantity, and, further, since the application of such methods of analysis to histology as the micro-spectroscope affords is of the very highest importance.—Various points relating to the instrument itself are discussed in these three parts by Dr. Royston Pigott, who figures his aplanatic searcher and its results on the Podura scale; by Messrs. Dudgeon, Newton, aud others, who describe new apparatus.—Mr. Moseley gives accounts of how to use gold chloride and silver nitrate in histological research, and how best to prepare and cut sections of the frog's egg for embryological study.—The original paper by Dr. Nitzsche, of Leipzig (illustrated), on the reproduction of the Bryozoa, and the reply to Mr. Hincks, are important, and on a very curious point. It is, however, to the chronicles and notes which we would especially call attention as of service to biological students. Long abstracts of all the important papers published in the German periodicals are to be found—in some cases illustrated by woodcuts; thus we have Neuman on the origin of the red blood corpucles, Kranse on connective tissue, Flemming on fatty tissue, Schöbl on the bat's wing and mouse's ear, Pflüger on the method of demonstrating nerve-endings in the liver and other glands, Exner on the Schneiderian membrane, Cienkowski on the sporogonia of *Noctiluca*, and many other such.

IN the *Journal of Botany* for October, Dr. Braithwaite continues his Recent Additions to our Moss Flora. Mr. R. Tucker gives some Notes on the now well-defined Flora of the Isle of Wight; and Dr. Moore Notes on some Irish Plants. Mr. F. Stratton contributes an article on *Monotropa hypopitys*, confirming the statement of other recent observers that this plant is not truly parasitic. The remainder of the number is occupied by short notes, reviews, reports, and reprints.

THE *Scottish Naturalist* for October opens with a timely reprint of an extract from Mr. Patrick Matthew's work on Naval Timber, published in 1831, and referred to in Darwin's "Origin of Species," in which he distinctly enunciates the theory that "circumstance and species have grown up together," or that new species have arisen from old species adapting themselves to altered circumstances. The most important original articles in the number are: The Baleens, or Whalebone Whales of the North-east of Scotland, by Mr. R. Walker; Notes on the Tetraonidæ of Perthshire, by Mr. R. Paton; On the Altitudes attained by Certain Plants (varying from those already recorded), by Dr. F. Buchanan White; and On Scottish Galls, by Mr. J. W. H. Traill.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 2.—M. C. Jorden read a mathematical paper "On the Classification of Primary Groups." Two papers on subjects connected with physics were read, one by M. A. Cornu, "On the Determination of the Velocity of Light," in which he suggests an improvement in the method proposed by Fizeau for this purpose, and a note by M. G. Salet on the Spectra of Tin and its components, which he describes as the most singular he has ever seen.—On astronomical subjects several communications were made.—M. Chasles replied to a statement made by M. Bertrand at a previous meeting with regard to Aboul Wéfa's method of calculating the position of the moon. M. Yvon Villareau communicated a long paper, full of mathematical formulæ, "On the Determination of the true Figure of the Earth, without the necessity of actual levellings."—M. Delaunay read a note on the two recently discovered planets, Nos. 116 and 117, in which he indicated that the planet discovered at Versailles by M. Borelly, and named Lomia, must be numbered 117, as the planet discovered by M. Luther two days afterwards had been previously detected in America by Mr. C. H. F. Peters.—

Letters on these planets by MM. Luther and Peters were also communicated by M. Leverrier, and M. Delaunay presented a determination of the orbit of Lomia by M. Tisserand.—The same gentleman a note on the nebulæ discovered by M. Stephan at Marseilles, and a note by M. Loewy on a new equatorial instrument. The latter is mounted like a transit instrument, but its body is bent at a right angle, and the images are carried to the eye of the observer by means of prisms or mirrors. The advantage, according to the author, is that the observer can carry on his investigations without changing his place, and that the necessity for an expensive revolving dome is done away with. —A fourth letter from Father Secchi, on the protuberances and other remarkable portions of the surface of the sun, was read. It contains a classification of the phenomena in question, and notices the chromosphere, protuberances, and clouds. Of the second several kinds are described.—M. de Fonvielle presented the programme of an intended balloon-ascent for the purpose of noticing the meteors of November 1871, and MM. Regnault and Elie de Beaumont made some remarks upon the same subject.—A letter was read from M. A. Poëy on the law of similar evolution of meteorological phenomena, in which he indicates the existence of a connection between the periodicity of meteorological phenomena and the diurnal and annual movements of the earth.—M. G. Lemoine presented a second part of his investigation of the reciprocal transformation of the two allotropic states of phosphorus, and M. Berthelot a second part of his researches upon ammoniacal salts. In the latter the author treats of the compounds of ammonia with boracic and carbonic acids.—A paper was read by M. C. Mène, giving numerous analyses of clays belonging to the carboniferous formation.—The tables of meteorological observations made at the Paris Observatory during the month of September was also communicated to the meeting.

October 9.—M. Bertrand presented a note by M. Painvin on the determination of the rays of a curve at any point of a surface defined by its tangential equation.—M. P. A. Favre read a continuation of his thermic investigations upon voltaic energy, in which he gives the results obtained by him in experiments with batteries containing fuming nitric acid, permanganic and sulphuric acids mixed, and hypochlorous acid. In connection with this subject, M. F. Le Blanc also presented a note on the energy of piles with two liquids. In a note on the most economical arrangements of voltaic batteries with regard to their polar electrodes, M. T. Du Moncel discusses the question of the desirability of reducing the size of the positive electrode.—M. Ruhmkorff described an arrangement for obtaining an exceedingly intense induced magneto-electric current. — Several astronomical papers were read, and among them a notice by M. Faye of the history and present state of the theory of comets, in which he contends for the existence of a repulsive force (*solar repulsion*) manifested in the phenomena of comets.—M. Delaunay announced that M. Stephan had observed Encke's comet at Marseilles on the night of the 8-9th October. In searching for this comet M. Stephan had discovered some new nebulæ.—M. Bertrand presented a reply to the remarks made by M. Chasles at the last meeting of the Academy on the determination of the position of the moon by Aboul Wéfa, and MM. Leverrier and Chasles remarked upon the desirability of searching the Oriental libraries for the astronomical writings of that author. — M. Delaunay communicated a note by M. Tisserand containing the determination of the orbit of the planet No. 116 (discovered by Mr. C. H. F. Peters).—M. Laugier presented a paper by M. Pagel, containing observations of the determination of the magnetic needle made at the Observatory of Toulon since the year 1866.—M. Roux presented an investigation of the artesian water of Rochefort, which comes up from a depth of nearly 857 metres. He gave a detailed analysis of the mineral contents of this water, and noticed the temperatures observed at various depths during the boring, which were considerably in excess of those recorded at Grenelle.—M. Billebault forwarded a note on the employment of gas-tar in the treatment of diseases of the vine, and especially against *Phylloxera vastatrix*. The destruction of this insect was also the subject of notes by MM. Peyrat and Deleuze.—M. E. Duclaux presented a note on a means of causing at will the hatching of silkworm eggs, which consists in exposing the eggs for a certain time to the action of cold.—In a note on the time which elapses between the excitation of the electric nerve of the torpedo and the discharge of its apparatus, M. Marey described some experiments made by him, from which it would appear that the nervous action is transmitted rather more slowly in the electric nerve than in the motor nerve of a muscle.—M. H. Sainte-Claire Deville communicated a note by M. A. Sanson on the theory of the early completion of the bones, in which the author replied to an objection to his theory made by a German writer.

PHILADELPHIA

Academy of Natural Sciences, February 6.—The President, Dr. Ruschenberger, in the chair. Prof. Leidy stated that he had recently received a small collection of fossils for examination from Prof. J. D. Whitney, who obtained them from California. The specimens are as follows:—A fragment of an inferior molar, apparently of *Mastodon americanus*. Of this specimen Prof. Whitney remarks that it was obtained from a depth of 80 feet beneath the basaltic lava of Table Mountain, Tuolumne County, Cal., where it was found in association with remains of human art. A much worn lower molar of a large horse, probably the *Equus pacificus*, from 16 feet on Gorden Gulch. The triturating surface of the crown measures $13\frac{1}{2}$ lines fore and aft, and 10 lines transversely, inclusive of the cementum. Two equine molar teeth, which, according to the accompanying label, were obtained 350 feet below the surface, at Soulsbyville, Tuolumne County, Cal. One is an unworn upper back molar, apparently of a species of *Protohippus*. It is moderately curved from behind forward and downward, but only slightly from within outward. It is 21 lines long in a straight line. Its greatest breadth above the middle, fore and aft, is nearly 9 lines; its thickness about 7 lines. The other tooth is a lower molar, about one-third worn, probably of the same species. The triturating surface is 10 lines fore and aft, and nearly 7 transversely. Two teeth labelled "Found ten feet below the surface at Dry Creek, near Bear Creek, Mercer County, Cal." One of the specimens appears to be the portion of a canine tooth, and the other is an incisor. They resemble in form the corresponding teeth of the lama, and probably belong to a species of the same genus. The incisor is about $1\frac{1}{2}$ inch in length; the crown externally is 11 lines long and $4\frac{1}{2}$ lines wide.

March 7.—The President, Dr. Ruschenberger, in the chair. Mr. Thomas Meehan referred to some observations he made before the Academy last autumn in regard to a peculiar storing up of turpentine in the common insect, *Reduvius novenarius*. Since then entomologists had been investigating the use for which this turpentine was employed, without success. He was now able to report that it was for the purpose of fastening its eggs on the branches of trees, and for sticking them together; also, in probability, as a means of protection against enemies and the weather. The eggs of the *Reduvius* were inserted in groups, and each set upright one against another with the turpentine, like the cell in a honeycomb. It had hitherto been supposed by entomologists that the matter used for this purpose was a secretion of the insect itself; but so far as he could judge by the senses, the matter used was merely turpentine, and no doubt the turpentine he had observed the insect storing up in the fall.—Mr. Meehan exhibited some flowers of the common *Bouvardia leiantha* of the greenhouses, and of the hardy *Deutzia gracilis*, and referred to his papers, published a few years ago in the Proceedings of the Academy, on practical diœcism in the trailing Arbutus (*Epigæa repens*) and *Mitchella repens*, in which he pointed out that these plants, though apparently hermaphrodite, had the stamens and pistils of different characters in separate plants, and were, therefore, subject to the laws of cross-fertilisation as indicated by Darwin. He had had his attention called to the *Bouvardia* by Mr. Tatnall, of Wilmington, Del., as furnishing a similar instance to that of *Epigæa* and *Mitchella*, to the same natural order as which, the *Cinchoneous* division of *Rubiaceæ*, the *Bouvardia* belonged. These had some plants with the pistils exserted, while in others only the stamens were visible at the mouth of the corolla tube. Mr. Tatnall had not had the matter suggested to him early enough to say that it was so in all cases; but he believed that these flowers, which practically might be termed pistillate and staminate, were found entirely on separate plants. This is a very important fact, as the *Bouvardia* is not raised from seeds in greenhouses, but from cuttings of the roots, and, therefore, all these plants with separate sexes must have been produced from one original individual, without the *intervention of seed*, and thus confirm the position advanced in a previous paper of the speaker on "Bud Variations," namely, that variations in form, and, by logical inference, new species, may arise without seminal intervention. In the specimens of *Deutzia gracilis* were two forms of flowers on the same plant. Besides the large ones with stamens and pistils apparently perfect, there were numerous small flowers in which the petals were only partially developed. The filaments were entirely wanting, but the anthers were as perfect, if not larger than in what we should call the perfect flowers. Any one could see that these small flowers were the result of deficient nutriment, and would be apt to pass the matter over with this simple reflection; but he wished to emphasise the fact that this defective nutrition rendered the female organs inoperative, while the male organs were still able to exercise their functions; thus affording another instance, if any more be needed, of the truth of his theory of sex, namely, that with defective nutrition, the female sex is the first to disappear, and that only under the highest conditions of vitality is the female sex formed. In the case of the *Bouvardia* a similar law was seen. The most vigorous stems, or, as they would technically be called, woody axes, produced the female flowers.—Prof. Cope made some observations on a Batrachian of the coal measures, *Sauropleura remex*, Cope. A specimen more perfect than the type recently obtained by Prof. Newberry exhibited posterior limbs such as has been ascribed to the *S. pectinata*. The vertebræ posterior to this point were perfectly preserved, and supported the remarkable processes to the end.

March 21.—Dr. Carson, vice-president, in the chair.—Prof. Leidy made the following remarks on *Tænia mediocanellata*. Recently, one of our ablest and most respected practitioners of medicine submitted to my examination a tapeworm which had been discharged from a young man, after the use of the *Aspidium filix-mas*. The physician, in giving an account of the case, stated that he had previously treated the patient for another affection, in which raw-beef sandwiches had been prescribed for food. After looking at the worm, I remarked that it appeared to be the *Tænia mediocanellata*, a species which I had not before seen, and added that the patient had probably become infected from a larva swallowed with the raw-beef sandwiches. The specimen consisted of the greater part of the worm, broken into several pieces. Including some lost portions, it was estimated to have been upwards of thirty feet in length. Unfortunately, the head proved to be absent; but, so far as characters could be obtained from the specimen, in the form of the segments, position of the genital orifices, and the condition of the ovaries, it agreed with the description given of *T. mediocanellata*, rather than with *T. solium*. From a want of acquaintance with the former, I did not feel entirely satisfied that the specimen actually belonged to that species. Subsequently, my friend brought to me the anterior part of the body, probably, of the same individual tapeworm. He observed that his patient continuing to complain, he had administered another dose of the male-fern, which was followed by the expulsion of the portion of the worm now presented. The head of the parasite was included, and it confirmed the view that it pertained to the *Tænia mediocanellata*. The case serves as another caution against the use of raw flesh as food. The description of the worm, as derived from the specimen, is as follows:—The head is white, without pigment-granules, obtusely rounded, unarmed with hooks, and unprovided with a rostellum, but furnished with a minute acetabuliform fovea at the summit. The four acetabula are spherical, and opaque white. The diameter of the head is three-fourths of a line. The neck, or unsegmented portion of the body immediately succeeding the head, is about four lines long by half a line in breadth. The most anterior indistinctly defined segments of the body, and those immediately succeeding them, but more distinctly separated, are about one-fifth of a line long by two-fifths of a line broad. In a more posterior fragment of the body, the flat and nearly square segments measure half a line long and one line broad, to one-third line long and two-and-a-half lines broad. A succeeding fragment exhibits segments three-and-a-half lines long by four lines broad, and two lines long by five lines broad. Many of the segments in this piece are irregularly separated laterally by deep, wide notches. In a succeeding long portion of the worm, the segments are wider behind than in front, and measure two, five, and three lines long by five lines broad. In a long piece of the posterior part of the worm, the segments are first four lines long and broad; and in the last four feet of the same piece, the segments are clavate in outline, from six to ten lines long, and two and three lines broad. The genital apertures are conspicuous, and are situated behind the middle of the segments. They alternate irregularly. Thus, in the last two feet of the posterior fragment of the worm, the first two segments exhibit the aperture on the left margin; the succeeding segment presents the anomaly of an aperture on both margins; then follow three apertures on the right, next two on the left, then four on the right, then eight alternating in pairs, then one on the left, and so on. The ovaries are opaque white, and exhibit numerous closely crowded lateral branches. In the absence of pigment-granules to the head, and in the less robust character of the worm, the specimen differs from *T. mediocanellata* as described by Küchenmeister. The minute acetabular pit or fovea at the summit of the head is not mentioned by Küchenmeister and subsequent observers as a character of that species. It is a point, however, that might be readily overlooked, especially if the parts of the head are obscured by the presence of pigment-granules.—Prof. Cope exhibited a number of fishes from the Amazon above the mouth of the Rio Negro, which included some new and rare forms. Some of the latter were *Doras brachiatus*, *Plecostomus scopularius*, *Roeboides rubrivertex*, *Myletes albiscopus*, &c. He exhibited a specimen of *Pariodon microps*, Kner, describing the parasitic habits of *Stegophilus* and those ascribed to *Vandellia*. He thought the structure and colouration of the *Pariodon* indicated similar habits, and that it would be found to be an inhabitant, at times at least, of the cavity of the body of some other animal.

BOOKS RECEIVED

ENGLISH.—Contributions to the Flora of Mentone, Part 4: J. T Moggridge (L. Reeve and Co.).—Words from a Layman's Ministry at Barnard Castle.—Transactions and Proceedings of the Royal Society of Victoria, Vol. viii., Parts 1, 2; Vol. ix., Parts 1, 2.

FOREIGN.—Nachtrag zum 6 u. 7 Jahresbericht des Vereins für Erdkunde zu Dresden. (Through Williams and Norgate.)—Die feierliche Sitzung der kaiserlichen Akademie der Wissenschaften zu Wien, 30 Mai, 1871.—Almanach der k Akademie der Wissenschaften zu Wien.—Oefversigt af k. Vetenskaps Akademiens Förhandlingar.

PAMPHLETS RECEIVED

ENGLISH.—Darwinism: Chauncey Wright.—The Cruise of the *Norna*: Marshal Hall.—The University of Durham College of Medicine, Syllabus for 1871-72.—The College of Physical Science, Newcastle-on-Tyne, Syllabus for 1871-72.—Observations on the Corona: Hercules Ellis.—Flint: M. H. Johnson.—The Scottish Naturalist. October.—Proceedings of the Meteorological Society, No. 56.—The Portfolio, No 22.—Quarterly Weather Report of the Meteorological Office.—Journal of the Statistical Society for September.—On the Faults in Ironstone Seams: R. L. Jack.—The Phœnix, Vol. ii, No. 14.—Journal of the Iron and Steel Institute, Vol. ii., No. 3.—Journal of the Scottish Meteorological Society, No. 31.—The Quarterly Journal for Microscopical Science, October.

AMERICAN AND COLONIAL.—On the Influence of the Blue Colour of the Sky in developing Animal and Vegetable Life: Philadelphia.—On the Eozöonal Limestones of Eastern Massachusetts: L. S. Burbank.—On the Characteristics of the Primary Groups of the Class of Mammals: Dr. Th. Gill.—The Canadian Naturalist, Vol. v., No. 4; Vol. vi., No. 1.—Proceedings of the American Philosophical Society, Philadelphia, Jan.-June.—Extracts from the Proceedings of the Lyceum of Natural History, New York.—Proceedings of the Asiatic Society of Bengal, No. 7.—The Canadian Entomologist.—The Rural New Yorker, Vol. xxi., Nos. 21-24.

FOREIGN.—Jahrbuch der k. k. geologischen Reichsanstalt zu Wien, 1871, April-June.—Georg Gottfried Gervinus: Emil Lehmann.—Magazine d'Education et de Recréation, No. 162.—Sur la loi de l'Evolution similaire des Phénomènes Météorologiques: M. A. Poëy.

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