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

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NATURAL SCIENCE AT THE UNIVERSITY OF CAMBRIDGE

IN endeavouring to give a brief sketch of the aids and encouragements to the student of Natural Science in this University, it will simplify matters to arrange our materials under three heads: (1) Instruction, (2) Appliances, (3) Inducements.

(1) INSTRUCTION.—This may be subdivided into (*a*) University, (*b*) Collegiate. As the relation between the University and the Colleges is often not understood by outsiders, it may be well to preface this part of our subject by a word of explanation. As it would clearly be impossible in most branches of learning for one, or even several, professors to teach the large number of students now resident in the University, the greater part of the work has to be done by the staff of tutors and lecturers in the various Colleges. Hence, in practice, a system of division of labour has grown up. The Colleges look after the general education of their students, and do the heavy work, undertaking almost the whole instruction of the rank and file in the Arts and Sciences; while the professor is held to be the representative of his particular department, whose duty is to do his best to advance its study, and be the organ by which the latest advances in it are communicated to the University at large. His work, therefore, is to fine-polish the tools which the Colleges have prepared. Hence, in one of the more frequented branches of study,—say, for example, that of mathematics,—the great mass of students never attend a professor's lecture at all; for them the instruction provided by the Colleges amply suffices; his class therefore consists of only a few of the ablest students, and he confines his instructions to those very difficult branches of mathematics on which perhaps few men besides himself can speak with much authority. In the case, however, of a branch of study followed by only a small number—say Sanscrit—the care of all the students may fall on the professor; but then, as the class cannot be a large one, this is not too heavy a burden. When, therefore, the demand for instruction in any such branch increases, the Colleges, either singly in the larger or by combination in the smaller Colleges, appoint lecturers to relieve the professor by taking charge of the average students, and by preparing the more able to attend his classes. This last is exactly the position of the Natural Sciences at the present time.

(*a*) To return, then, after this digression to the University Instruction in the Natural Sciences. At the present time, without reckoning the two purely Medical Professors, there are six Professorships in the University: that of

	Founded in	At present held by
Anatomy*	1707	Dr. Humphry.
Botany	1724	Prof. C. C. Babington.
Chemistry	1702	Prof. Liveing.
Geology	1727	Prof. Sedgwick.
Mineralogy	1808	Prof. W. H. Miller.
Zoology	1866	Prof. A. Newton.

The number of lectures given varies considerably, depending mainly on the requirements of the students; the smallest being one course of four days a week in one term, while the largest is two courses each of three days a week in every term.

(*b*) Collegiate. Trinity College has one lecturer in the Natural Sciences; St. John's College has two; and the present lecturers have made arrangements by which the lectures are common to the two Colleges: the subjects thus covered being Physics, Chemistry, Geology, and Elementary Botany. Sidney Sussex College has one lecturer in the Natural Sciences, and Downing two "in Medicine and Natural Science." We believe that these lecturers also admit to their lectures students from the neighbouring Colleges.

(2) APPLIANCES.—The University possesses various collections, &c., accessible to students. These are: the Museum of Human Anatomy and Pathology, which is strong in the latter department, but not so well supplied in the former. The Botanical Museum, containing the collections formed by the late Professor Henslow with the herbaria of Drs. Lehmann and Lindley, and considerable additions that have been made from time to time. These for many years could not be properly exhibited owing to want of space, but they have been recently established in a suite of rooms in the New Museums and Lecture Rooms Buildings, and provided with convenient cases in which they are being rapidly arranged. There is also a large Botanic Garden, with hothouses, &c. The Professor of Chemistry has a small Museum of Chemical Preparations, with Laboratories that will accommodate about forty students at once. The Geological Museum, which occupies the ground-floor rooms under a part of the Public Library, had for its nucleus the collection of Dr. Woodward, the first professor. Since then it has been constantly augmented by many valuable gifts, and by the energy and liberality of the present occupant of the chair, the venerable Professor Sedgwick. It is peculiarly rich in Palæozoic, Cretaceous, and Eocene fossils; containing, among others, collections from the Cretaceous rocks by Mr. Image and by Dr. Forbes Young, of Saurians from the Lias by Mr. Hawkins, of Dudley fossils by Captain Fletcher. There is, we believe, no Museum where the palæontology of East England can be better studied. It also contains some good sets of Continental fossils, and a remarkably fine series of rock specimens collected by the present professor. On the whole it is a collection of which the University may justly be proud. The Mineralogical Museum now occupies a suite of rooms above that of Botany, and its arrangement is almost completed. It originated in the collection formed by Dr. E. D. Clarke; but has since been greatly augmented, having received the entire collections of Mr. H. Warburton, Dr. Forbes Young, Lord Lilford, Viscount Alford, and Mr. H. J. Brooke, besides large donations from Dr. Whewell and others. Rooms for purposes of study are attached to the Museum. The Museum of Comparative Anatomy contains the nucleus of a fine collection in Comparative Osteology, numbering more than 2,000 specimens, with a collection of Invertebrata and a Physiological series. It owes much to the energy and liberality of the late Professor of Anatomy, Dr. Clark, and of his son, Mr. J. W. Clark, the present superintendent of this and the Zoological Museum. The latter Museum, now in process of arrangement, contains some good collections of birds

* The University also provides a demonstrator in Anatomy to assist the professor.

and fishes. In the Colleges, there are laboratories at St. John's, Sidney Sussex, and Downing; and we believe that Trinity College contemplates establishing one.

(3) INDUCEMENTS.—The degree of B.A. may be obtained in Natural Sciences. An examination in Honours was instituted in 1851; in 1861 the regulations were revised, and the successful candidates were declared entitled to a degree. Ninety-five students have passed this examination in the nine years since the alteration. A candidate for an ordinary degree may also select for the subject of his third or final examination one of the following subjects: Chemistry, Physics, Geology, Botany, Zoology. In the Colleges: Clare gives annually a scholarship, value 50*l.*; Caius two, value not stated, one for Chemistry, the other for Anatomy; Christ's has lately offered scholarships, from one to four in number, and from 30*l.* to 70*l.* in value, according to the merit of the candidates; St. Peter's gives annually one of the value of 60*l.*; St. John's gives annually an exhibition of 50*l.* for three years to students commencing residence; this College has also just instituted an annual examination in the Natural Sciences for its resident students, for proficiency in which prizes in books and pecuniary rewards will be given, as in the other College examinations; Trinity gives annually one foundation scholarship, tenable till the holder is of M.A. standing; Sidney Sussex, two scholarships annually, value 40*l.*, with opportunity of promotion, for Mathematics or Natural Science; Downing gives annually at least one scholarship, value 40*l.* A fuller description of these will be found in No. 6 of this periodical, p. 169.

In looking through the lists of the Natural Sciences Tripos, fourteen persons will be found to have been elected fellows, but in most cases the candidate has been not without distinction in other branches of study. In several, however, proficiency in Natural Science was the declared cause of the election.

These statements are made upon the authority of the last volume of the Cambridge Calendar, supplemented in some instances by personal knowledge.

Thus much has been done: of what remains to do it is perhaps better that one, who is a resident and engaged to some extent in the work, should refrain from speaking. On this point only I may venture to express my conviction, that the coldness and even dislike with which the study of Natural Science was once regarded here is rapidly passing away, that the number of earnest students in the various branches is annually increasing, and that the University is fully alive to the wants of the age; so that, while she can never neglect or forget those old paths of Classics and Mathematics in which many of her sons have won an almost world-wide reputation, she will heartily welcome, and will regard with no less pride, all who are among the followers of sciences of a more recent date.

T. G. BONNEY

THE MEASUREMENT OF GEOLOGICAL TIME

II.

WE have now to consider an entirely distinct set of facts which have an important bearing on the probable time elapsed since the last glacial epoch. Messrs. A. Tylor, Croll, and Geikie have shown that the amount of denudation now taking place is much greater than has generally been supposed. The quantity of water discharged by several rivers and the quantity of sediment carried down by those rivers have been measured with tolerable accuracy, and allowing for the difference of specific gravity between sediment and rock, it can be easily calculated, from the known area of each river basin, what average thickness has been removed from its whole surface in a year, since all the matter brought down by the river must evidently have come from some part of its basin. In this way it is found that the Mississippi has its basin lowered $\frac{1}{6000}$ of a foot per annum; the Ganges, $\frac{1}{2358}$; the Rhone, $\frac{1}{1528}$; the Hoang-Ho, $\frac{1}{1464}$; the Po, $\frac{1}{729}$.

But it is evident that this amount will be distributed very unequally over different parts of the basin, according as the surface is flat or sloping, whether the slopes are of loose soil or of rock, whether the rock is solid or friable. The perfectly flat alluvial plains that form a considerable part of many river basins, will not only suffer no denudation, but will generally receive deposits of sediment during floods, and all such flat lands should therefore be deducted from the area of the river. Slightly undulating lands, especially if well covered with forest, will also suffer scarcely any denudation, as is well seen in the case of the Rio Negro branch of the Amazon and other black water rivers of South America, which hardly carry down any perceptible sediment even when in full flood. Again, wherever lakes occur, they receive all the sediment from the basin above them, which portion should therefore be treated by itself, since it contributes no sediment to the main river. If we look at a physical map of North America we see that a large extent of the Mississippi basin consists of alluvial flats and slightly undulating prairie, sufficiently explaining its small proportionate denudation. Even the Rhone, which has a high rate of denudation, flows through a great extent of low lands and perfectly flat meadows, while the upper portion of its valley which produces most sediment is cut off by the Lake of Geneva. In order, therefore, to arrive at any fair estimate of the amount of denudation in the upland and mountainous portions of the Rhone valley (which is what we require for our purpose) we have considerably to reduce the area of its basin by taking away the flat lands in all its valleys, and considerably to increase the amount of sediment by adding all that is now poured into the Lake of Geneva. We shall probably not be far wrong in adding one third to its denuding powers on these grounds, which will lead us to the startling fact that the Rhone basin is being lowered at the rate of a foot in a thousand years; but even this is considerably less than in the case of the Po. Mr. Croll takes the Mississippi denudation of a foot in six thousand years as a measure for that of Europe; but for reasons above stated I conceive this to be quite out of the question, and I maintain, that if we are to use his measure of denudation for any practical purpose, we must apply that of European rivers to European phenomena, that of Alpine rivers to Alpine phenomena, and must further make the necessary corrections for alluvial flats and intercepting lakes.

Mr. Croll and Sir Charles Lyell were at first both inclined to adopt the period of high excentricity which occurred from 750,000 to 950,000 years ago as that of the glacial epoch, but Mr. Croll, in consideration of the proofs of rapid denudation above given, now believes that the

period beginning about 240,000 and ending about 80,000 years ago, is the more likely one. Even this, however, offers difficulties. Denudation in Wales and Scotland must probably have gone on as rapidly as the average rate of the Rhone valley, especially during the period when the old glaciers were disappearing; and eighty thousand years will therefore imply eighty feet of average denudation over the whole surface of the country, if less in one part then correspondingly more in another; but how is this consistent with the preservation of ice-ground rock-surfaces and glacial furrows in so many situations, as well as numberless heaps of loose matter, the moraines of ancient glaciers, apparently just as they were left by the ice? There are, it is true, a few considerations that go to diminish though not to remove the difficulty. The amount of denudation is now abnormally large, because the large quantities of glacial drift left over the surface of the country, supply much of the sediment carried down by the streams of Alpine countries. Many glacial markings were at first covered up and preserved by drift or alluvium, and have been since exposed by denudation: those earliest exposed are obliterated, but new surfaces are being continually uncovered. The amount of denudation of a solid rock-surface may not be a tenth part of that which now obtains in glaciated districts; a fact which can only be ascertained by determining the amount of sediment brought down by streams the basins of which are *free from drift or gravel*, and consist almost wholly of *compact rock surfaces*. We still have to deal with the difficulty of the moraines, whose form and aspect are often so fresh that we can hardly believe them to have been much changed since the ice left them, although it is impossible to understand how they have escaped the denudation which has lowered the whole surface of the country eighty, or even a much smaller number of feet.

It is true Mr. Geikie, in his paper on Modern Denudation,* suggests that all the effects of ice-action, now visible, are merely the few examples which have been preserved owing to a concurrence of favourable conditions, while a much larger number have been destroyed; and I learn from him that there are in Scotland moraines in all stages of decay. If this be the true explanation of the difficulty, it follows that denudation must be extremely unequal, and that if one valley or hill-side has remained unaltered during 80,000 years, another must have been denuded to double the average amount.

Having thus shown the difficulty there is in accepting even the shorter period of 80,000 years for the date of the end of the glacial epoch in Europe, let us see what other modes of measurement are available. In Sir Charles Lyell's "Antiquity of Man," 2nd ed., p. 28, we have three different calculations of the age of the bronze and stone periods in Switzerland, which would place the latter at about from 5,000 to 7,000 years ago. At page 321 of the same work, we have an estimate of the age of the upper delta of the Tinière by M. Morlot. The lower delta (by the presence of Roman remains in one of the upper strata) is calculated with tolerable certainty to be 10,000 years old, while the upper delta, 150 ft. above the lake, is ten times as large as the lower one, and is therefore supposed to be 100,000 years old. From its fossil remains it is believed to be post-glacial; but it is evident that, during the melting of the ice, the torrent might have been more powerful, and have accumulated a delta much more rapidly than now. The peat mosses of Denmark, indicating that the present beech-tree vegetation of that country, which was also characteristic of it in the Roman period, was in the Bronze age replaced by oaks, and in the still earlier Stone age by fir-trees, imply a very long lapse of time; yet this only takes us back to the Neolithic age, when all the shells and all the mammalia were of existing species. The 8,000 or 10,000 years of the Swiss Stone age may, however, have sufficed for this change. There seems to be no doubt, that the time which elapsed from the close of the glacial epoch (when man used the rudest flint weapons, and was coeval with many extinct animals, when, moreover, the climate and physical features of the country were considerably different from what they are now) up to the Neolithic age, was much greater than from the latter date to the present day, but how much greater it is impossible to determine. The position of many of the tool-bearing gravels shows that rivers then flowed at much higher levels, but from the known rate of denudation, a valley might be deepened even 50 or 100 ft. in as little as 50,000 years, since it is in valleys that the effects of denudation would be greatest; and the extinction of the various animals might certainly take place in an equal time under such conditions as are not unlikely to have occurred at a period of great climatic change.

It does not appear, therefore, that any of the estimates of time founded on an actual basis of observed change in a known period, require us to assume more than 80,000 years since the close of the glacial epoch, while the measurement of the existing rate of denudation renders it almost certain that it was less rather than more. We may fairly assume, that even if a large excentricity has been an essential condition of a glacial epoch, the ice would maintain itself into a period of less excentricity than would be required to bring one on. Now 74,000 years ago the excentricity was about double what it is now, and the winter of the northern hemisphere then occurred in *aphelion*, so that the glacial epoch would at that time probably have been in full force, and we may assume that it might continue 3,000 or 4,000 years longer. But when we come to 65,000 years back, we find the excentricity scarcely more than it is at present, and winter nearly in *perihelion;* so that we must conclude, if excentricity has anything to do with it, that the last glacial period came to an end not less than 70,000 years ago.

Now it is most important to observe that, for the last 60,000 years, the excentricity has been very small—for three-fourths of the time less than it is now. During this time the opposite phases of precession, each lasting 10,500 years, will have produced scarcely any effect on climate, which in every part of the earth will have been *nearly uniform for that long period*. But this is quite an exceptional state of things; for the curve of excentricity shows us that, during almost the whole of the last three million years, the excentricity has been high—almost always twice, and sometimes three and four times as much as it is now. If, therefore, Mr. Croll's theory be correct, there will have been a change each 10,500 years during this vast period (in all the extra-tropical regions at least) from a very cold to a very mild

* Transactions of the Geological Society of Glasgow, vol. iii. p. 153.

climate. This will necessarily have caused much migration both of plants and animals, which would inevitably result in much extinction and comparatively rapid modification. Allied races would be continually brought into competition, altered physical conditions would induce variation, and thus we should have all the elements for natural selection and the struggle for life, to work upon and develop new races. High excentricity would therefore lead to a rapid change of species, low excentricity to a persistence of the same forms; and, as we are now, and have been for 60,000 years, in a period of low excentricity, *the rate of change of species during that time may be no measure of the rate that has generally obtained in past geological epochs*. Thus we should have explained the extraordinary persistence of organic forms during the historical period as well as during the preceding Neolithic age, although slight changes of climate and of physical geography have undoubtedly taken place; and it would prove to be not so much the *usually* slow rate ot organic change, as the fact of our living in the midst of an *exceptionally uniform climatic epoch*, that has hitherto prevented us from obtaining a measure of the average duration of species.

These considerations have an important bearing on our estimate of the duration of the glacial epoch itself, and on our calculation of geological time from the change of species since its commencement. If it terminated 70,000 years ago, and if each 10,500 years before that date, there was alternately a warm period and a glacial epoch, there would necessarily occur a series of northern and southern migrations of animals and plants, and thus deposits formed at times not geologically remote, might contain very distinct groups of animals. These might even meet and be confounded in the same strata, and thus lead to that extraordinary mixture of northern and southern forms which occurs in some of the more recent formations, like the hippopotamus and mammoth in the Norfolk crag and the lower brick-earths.

Geologists seem hardly to have attached sufficient importance to the great gap that intervenes between the Palæolithic and Pre-historic ages. Mr. Boyd Dawkins has shown, from a careful study of their mammalian remains, that the whole of the post-glacial river deposits and cave-beds of this country (148 in number) are of the same age, being characterised by about twenty species of extinct or arctic mammalia, and this was the age of Palæolithic man. In the Pre-historic or Neolithic age all these have disappeared, while the sheep, goat, dog, and *Bos longifrons* are first met with. Now, on the theory that this Palæolithic age was entirely post-glacial, and that the climate and physical geography of Britain have been since slowly approaching their present condition, how is this great gap to be accounted for? The large number of places where remains have been found, shows that the conditions requisite for preserving them very frequently occurred, and there must therefore have been some special cause which has prevented any record being left of the long period during which they were becoming extinct. Mr. J. Scott Moore* maintains that they were all pre-glacial, and that the gap was the glacial epoch itself. He adduces in corroboration the striking fact that none of the supposed post-glacial gravels ever rest on the boulder clay, but always on an older rock, which could hardly have been the case in every instance were they all post-glacial. Again, Mr. Boyd Dawkins tells us that the identity of such a large proportion of the species of pre-glacial and post-glacial mammals "forbids the idea of the existence of any gap or lacuna which would warrant the classification of the one as tertiary and the other as quaternary." But if we admit the occurrence, during the last glacial epoch, not only of one or two, but of a series of alternate cold and warm periods, we may make the Palæolithic age *inter-glacial*, and suppose it to have occupied several of these alternations of climate. If we further place the last submergence which separated Britain from the Continent, during one of the later phases of extreme cold, when most of the extinct mammalia, as well as man, had migrated southwards, we shall sufficiently account for the great gap that intervenes between the Palæolithic and Pre-historic ages.

In the "Principles of Geology," 10th ed., vol. i. p. 300, Sir C. Lyell has given an estimate of the duration of geological epochs, from the proportionate change in the species of marine mollusca, taking as a basis a million years since the beginning of the glacial epoch. Of the marine shells then living, six per cent. have become extinct, while at the close of the glacial epoch they were all of existing species, but this does not necessarily imply that the former are many times older than the latter. The glacial period itself may have been the cause of their extinction independently of mere time; so that the Bridlington beds, where the above-mentioned proportion of extinct species occurs, need not on this account be more than twice as old as those glacial or post-glacial drifts which contain only living species, or, according to our previous estimate, about 140,000 years. The Norfolk crag, which contains eleven per cent. of extinct shells, may be from 40,000 to 60,000 years older; this will allow for two or three alternations of warm and cold periods, which, at a time of such high excentricity, must have been strongly contrasted, and have led to a correspondingly rapid change of species. From these considerations it becomes evident that the time, measured by the occurrence of five per cent. of extinct species of marine shells, is not necessarily the whole number of years which has elapsed since they existed, but only that number *minus* the last 60,000 years of uniform climate and specific immobility; and we may be even too lavish of time if we allow so much as 100,000 years for this amount of change under the influence of those repeated alternations of climate which have characterised the last three million years and which have probably more or less characterised all past geological time. If now we take this number as our datum instead of a million years, all Sir Charles Lyell's figures will be reduced to a tenth, and will stand thus: the time elapsed since the beginning of the—

Lower Miocene . . .	2,000,000 years.
Eocene	6,000,000 ,,
Cretaceous	10,000,000 ,,
Triassic	14,000,000 ,,
Permian	16,000,000 ,,
Carboniferous	18,000,000 ,,
Devonian	20,000,000 ,,
Silurian	22,000,000 ,,
Cambrian	24,000,000 ,,

These figures will seem very small to some geologists who have been accustomed to speak of "millions" as

* Pre-glacial Man and Geological Chronology. Dublin, 1868.

small matters; but I hope I have shown that, so far as we have any means at present of measuring geological time, they may be amply sufficient. Taking Sir William Thomson's allowance of a hundred million years for the time during which the earth can have been fit for life, it yet allows Mr. Darwin, for the process of development from the primordial germ, three times as many years anterior to the Cambrian epoch as have elapsed since that date, an amount of time which, I believe, will fully satisfy him, by whatever scale we may measure it.

The evidence of the rapidity of denudation would indeed tend to the still further shortening of the estimate here given; and it is not impossible that a concurrence of geographical conditions might have brought down the glacial epoch into a period when the excentricity was no greater, or even less, than it is now. This, however, is hardly probable, and I am inclined to think that the considerations already alluded to will, to a considerable extent, explain how it is that so many signs of glacial action still remain, in spite of such denudation. The only argument I consider new in this paper, is that derived from the uniformity of climate during the last 60,000 years, and the alternations of heat and cold for a long time previously, leading to a slower change of species since the glacial epoch than at any former period, thus allowing us to suppose change of form in the organic world to go on more rapidly than we had before thought possible. If this be a sound deduction, it will, I believe, more than anything else, enable us to bring the period required for the development of the whole organic world within that which modern natural philosophy assigns as the age of the habitable earth.

Much of the force of my argument appears to depend upon the accuracy of Mr. Croll's view, that, during a time of great excentricity, there will be in each hemisphere alternately a glacial epoch for about 10,500 years, and a perpetual spring or summer for about an equal period. But Sir Charles Lyell argues, with great force, for the opposite view, that the cold of one period would be continued through the other, and that during the whole continuance of a phase of high excentricity both hemispheres would be in a state of glaciation. Supposing this view to be the true one, it will not very materially affect my argument, for the diagram shows many comparatively rapid alternations from a very high to a very low excentricity, which would also be from a glacial to a temperate climate and would certainly tend to comparative rapidity of specific change; while in each 10,500 years there would, no doubt, be some retreat and advance of the snow line, followed by a less amount of migration, competition, and variation. During the last 60,000 years, on the other hand, the change of excentricity has been hardly perceptible, and the change of organic forms may be supposed to have been far below the average.

ALFRED R. WALLACE

FRESHWATER CRUSTACEA OF NORWAY

Histoire Naturelle des Crustacés d'eau douce de Norvège; by George Ossian Sars. Part I. Malacostraca. With 10 plates. (Christiania, 1867.)

SOME few years ago, much interest was excited amongst naturalists by the announcement of the occurrence, in the great Swedish lakes Venner and Vetter, of certain Crustacea, heretofore known only as marine species inhabiting the Arctic and Baltic Seas. The author of this discovery was Professor Lovèn; and the explanation of it appeared to be, that the gradual elevation of the Scandinavian peninsula had cut off these originally marine creatures from their natural habitat, and that they had been able to accommodate themselves successfully to altered conditions of life.

In the volume now under notice, we have an elaborate—we may say almost an exhaustive—contribution to the natural history of these and other fresh-water crustacea of Norway. The species here treated are *Mysis oculata*, var. *relicta; Gammarus neglectus; Pallasia cancelloides*, var. *quadrispinosa; Gammaracanthus loricatus*, var. *lacustris; Pontoporeia affinis*; and *Asellus aquaticus*. One notices with surprise the absence of the most abundant fresh-water Amphipod of our own country, *Gammarus pulex*, and its replacement by the very closely allied *G. neglectus*. The well-shrimps (*Niphargus*) seem also to be unnoticed as yet in Norway; neither do we find any mention of another group, inhabiting chiefly brackish water, but in some districts of England reaching into situations which, though affected more or less by tides, are yet of quite fresh-water character; e. g. *Palæmon varians* and *Mysis vulgaris*.

The anatomy and physiology of all these animals, and their points of variation from the typical marine forms, are most carefully and elaborately worked out. The following interesting remarks occur respecting *Pontoporeia affinis*. The males of this species are numerous, having their antennæ either imperfectly developed or presenting a very peculiar form, except in some individuals, where, towards the end of autumn, the antennæ take on their fully developed form; in both cases, the animals being perfectly fertile. This phenomenon is analogous to some already observed in the Cumacea and Tanaidæ. The great likeness between this and the Greenland species, *P. femorata*, led the author at one time to consider the two as presenting only varietal differences, the Norwegian species exhibiting a permanent arrest of development such as he shows to be the case with the variety *relicta* of *Mysis oculata*. This supposition, however, he was compelled to dismiss; one important fact tending to a contrary opinion being that the secondary appendage of the superior antenna contains in *P. affinis* a larger number of joints than in *P. femorata*.

We would commend the dredging of our deeper lakes to the attention of English naturalists. Nothing in that direction has, so far as we know, been done in this country; and it is worthy of remark, that only in the very greatest depths of the Scandinavian lakes were the abnormal species found. That this field is not unlikely to prove a productive one near our own doors we fully believe, inasmuch as we have ourselves found, and elsewhere published, some interesting instances of the occurrence of truly marine microscopic crustacea in fresh water in the west of Ireland.

It should be added, that the plates illustrating M. Sars' work are admirable specimens of the engraver's art, and leave nothing to be desired as to copiousness and accuracy. The work is altogether well produced; the expenses, which we fear are scarcely likely to be repaid, having been generously borne by the publisher, M. le Réviseur d'Etat Johnsen.

G. S. B.

THE THREE KINGDOMS OF NATURE

The Three Kingdoms of Nature, briefly described. By the Rev. S. Haughton, F.R.S., M.D. Dubl., D.C.L. Oxon, &c. (London: Cassell, Petter, and Galpin.)

THIS little work resembles a modern novel in one particular: it is written with an idea.

The learned author, in his preface, lays down the law that "the faculties of our mind are developed in succession as we advance in age, each of them reaching its maximum and then gradually diminishing. In childhood the senses acquire their greatest development; in boyhood and youth, the memory and imagination; in early manhood, the purely reasoning faculties; and in adult life, the judgment." He accordingly draws the conclusion that "the child should be instructed mainly through his sensations; the boy should learn languages, ancient and modern, and natural history, so far as it depends on observation; the youth should cultivate mathematics and logic; while studies such as ethics, physiology, and politics should be reserved for the more mature period of life:" and offers this work as a text-book on Natural History.

We must confess that the above law seems to us to be barely a half-truth. We admit that the senses are relatively strongest in childhood, but not absolutely. So far from their attaining their maximum development at that age, and then gradually diminishing, we believe that the senses of the truly fashioned man are at their height when he is in the prime of life; and that in the properly trained man, memory, imagination, reason, and judgment, all flourish at the same time.

We are apt to forget into what a wretchedly cramped and artificial condition so many generations of schoolmasters have bred us. Each of us, generation after generation, has very early been made to put Chinese shoes on most of the feet of his mind.

We all see the sportive, elastic, quick, sharp, unwearying work of the senses of a little child. We do not all of us bear in mind to how fearful an extent those senses are bruised and deadened by the pedantry of our pedagogues. Men who cultivate those sciences in which success is inseparable from agile sense, know at what cost and labour, in later life, sometimes even in their full prime, they have had to go back and undo all that their schoolmasters have done, have had to become little children again for the sake of a sharper eye and a quicker ear. To ourselves, there is nothing more disheartening than to study a little boy, of eight or ten years of age, who has never been to school, tracing out in his mind with ease nascent scientific capabilities; then to know the same little boy after he has enjoyed for two or three years the great advantages of a grammar or a commercial school, or a private academy, and to find his mind as blank and as deadened as his moral nature.

We do not feel inclined, then, to accept the physiological law laid down by Dr. Haughton, but we are not thereby prevented from agreeing with him that "Natural History (as a school study) is inferior to no other study, not even language, as a means of cultivating the memory and observation," or from accepting his brief description of the three kingdoms as a capital instrument of teaching.

The first part contains, besides an introductory and extremely lucid chapter on Crystallography, a detailed but succinct description of the various minerals found in Nature; the chemical composition, physical characters, crystalline forms, geological and geographical distribution of each being briefly given.

The second part treats of the Vegetable kingdom; dealing somewhat fully with the anatomy, more briefly with the physiology, of plants, and devoting only some dozen pages or so to classification.

The third part, comprising nearly half the volume, describes the Animal kingdom, beginning with mammalia and working down to protozoans. In each subdivision a brief anatomical history precedes the classification, which is given pretty fully. Formal definitions in italics, of classes and orders, are relieved by popular descriptions of the habits and features of species and individuals; and the whole work is largely illustrated by many excellent woodcuts.

Although so large a field is gone over, the matter is on the whole eminently exact and truthful; and the author has probably given an indication of the judgment of the mature period, by hesitating to place in a dogmatic text-book views on various points which are certainly recent, and may turn out to be raw. We may congratulate Dr. Haughton on having compressed a vast amount of information into a small compass. But is only right to add one more observation: the book is very formal, even to exceeding toughness. Though quotations from the poets, Aristotle, and Scripture appear here and there, the general reader would, we fear, find it very dry. As a text-book in the hands of a teacher, it will commend itself to every one; we doubt if any but very strong-minded persons would choose it for self-instruction, except with the fear of an examination before them. M. F.

OUR BOOK SHELF

Baillon's Cæsalpineæ.—*Histoire des Plantes:—Monographie des Legumineuses Cæsalpinées.* Par H. Baillon. (Paris: Hachette, 1869. London: Williams and Norgate.)

WE have so recently reviewed the first volume of Baillon's "History of Plants" (see NATURE, No 2, p. 52) and discussed his mode of treating the subject, that we need scarcely more than mention the publication of his monograph of the important order or sub-order of *Cæsalpineæ*. The boundary-line between this sub-order and the *Papilionaceæ* is very difficult to be accurately laid down. M. Baillon describes the *Cæsalpineæ* to be, in general terms, those *Leguminosæ* which have a straight embryo and the æstivation not vexillary in the bud; but neither of these diagnostics can be relied on as absolutely constant. All the other characters dependent on the regularity or irregularity of the corolla, the cohesion of the stamens, the number of seeds, the presence or absence of albumen, &c., are still more uncertain. There are even species so far removed from the normal type of the order as to have undivided leaves, indefinite stamens, diclinous flowers, and herbaceous stems. A. W. B.

Ueber die Fortpflanzungs-Geschwindigkeit des Schalles in Rohren. Von Adolf Seebeck. (Göttingen, 1869.)

IN this inaugural dissertation, Herr A. Seebeck, the inheritor of a name famous in physical science, gives an account of his experiments on the velocity of the propagation of sound in pipes. The results are extremely interesting and important.

In 1867, Professor Kundt, of Zurich, proved that the velocity of sound in pipes depends on their cross section, and attributed the result to the loss of heat in the friction

of the gases on the enclosing wall. Kirchhoff deduced the consequences of this theory mathematically, and pointed out that the diminution of velocity must vary inversely as the square root of the number of vibrations in the sound propagated; that is to say, that the velocity of sound could not be uniform for different notes. Seebeck shows that the loss is inversely as the cube of the square root of the number of vibrations; so that we can scarcely attribute the result entirely to the loss of heat by friction of the enclosed gas on the walls of the tube. On the other hand, his results completely establish the fact of a difference in the speed with which different notes of music are propagated in tubes.

The magnificent and laborious work of M. Regnault on the velocity of sound in pipes, appeared while Seebeck was occupied in these investigations. He points out, that since the sounds which Regnault studied, such as explosions of gunpowder and so on, are due to violent and complicated disturbances, however important it may be to study them in a practical view, they are not likely to give us accurate and delicately differenced results. Where the sound contains a mass of irregular notes, no effect due to difference of note can be observed. The method of generation compels the air to move at first in all directions in the tube. Such sounds fall into the sea of air like a mass of stone dropped from a great height into the water. The waves which they generate can only reduce themselves to regularity at some distance from the disturbance and their propagation must be irregular till that distance is reached. On the other hand, a regular pulsation, such as would be produced by the timed advance and retrogression of a piston at the end of the cylinder, gives waves which are regular and regularly propagated from the beginning. It is in consequence of this delicacy in the character of his experiments that Seebeck has attained his results.

He makes one of König's tuning-forks sound at the open mouth of a cylindrical pipe, the other end of which is stopped by a moveable piston. A short distance from the mouth of this pipe there is an opening, connected with an indiarubber tube which can be carried to the ear. If, by the motion of the moveable piston, this opening be made to correspond exactly to a "ventre" in the standing wave which is generated in the air of the tube, it is easy to measure, with great accuracy, the length of that standing wave, which corresponds to the precise number of vibrations of the tuning-fork. The extreme difference in fifty experiments for the same note, appears to have been about one five-hundredth of the whole amount.

The results are the following, the velocities being reduced from the experiments to those at 0° C.:

	Diameter of pipe in millimetres.	Velocities reduced to 0°, in metres per second.				Number of vibrations per second in note sounded.
1.	3·4	322·90	318·86	317·26	——	512, 384, 320, 256
2.	9·0	328·44	327·68	327·22	325·63	
3.	17·5	330·92	329·86	329·24	327·82	
4.	29·0	326·10	326·72	325·36	324·54	

If we compare these numbers with that for the speed of propagation in free space, as given by Schröder von der Kolk, which is 332·77, we see (1) that they are *uniformly* and considerably *less;* (2) the divergence *is greatest in narrow tubes*, with the exception of that where the tube was 29 millimetres in diameter, which was in all probability too wide to have the mass of air at its end uniformly affected by the vibrating tuning-fork; (3) the notes which travel slowest are the *low notes*. This difference is by far the greatest in the case of the narrow tube of an eighth of an inch in diameter, amounting to nearly 1 in 60 of the whole amount for the notes *e* and c_2.

The author discusses the further question, whether the nature of the enclosing tube produces any effect. In a tube, the inside of which is sheet copper, which has nearly 17 mm. diameter, the velocity is as low as it is in a glass tube of 9 mm. Where the friction is raised to a maximum by coating the inside wall of the tube with flannel, the velocity is reduced to 293·7 metres per second in a tube of 13 mm. diameter.

The same subject is treated fully by Herr Schneebeli, in a series of experiments published in Poggendorff's *Annalen* in February of last year; but those which we have described appear to us to have conducted their author to more valuable and interesting results.

WILLIAM JACK

An Introduction to the Study of Chymistry. Written for the People by Cuthbert C. Grundy. Pp. 108. (London: Simpkin, Marshall, and Co.)

WE remember when at school being called upon to admire the beauties of Schiller's *Wilhelm Tell.* Our impressions of that play were then by no means complimentary to some of the principal personages: so far as we could see Melcthal, Stauffacher and the rest of the members of the three Cantons apparently did nothing but meet clandestinely (when the weather was favourable) to talk much treason and fine sentiment, generously leaving most of the hard work to be performed by Tell (who being lowly-born was perhaps not so free of speech). All this was doubtless wrong and absurd; but we are reminded of these early impressions by the character of much of what is being said and done in reference to the education of the masses in the present movements. There is a wonderful disparity in the proportion of Tells to our ideal Melcthals and Stauffachers. Possibly, if certain noisy persons would but show their earnestness in the practical manner of Mr. Grundy, the wheels of progress would not drag so heavily.

In a modest little preface, Mr. Grundy informs us that his book is mainly intended for those among the great body of the people who desire knowledge, but have little time and only limited means for acquiring it. Occasionally, for example, when defining and illustrating the phenomena of latent heat, the author lays himself open to the charge of sacrificing precision of knowledge to clearness of statement. This fault is not unfrequently met with in manuals of this character: surely the two are not incompatible. Why does Mr. Grundy prefer the more antiquated form of styling the science? The generally accepted word is undoubtedly more correct: Kopp has satisfactorily shown this in his recently published "Beiträge zur Geschichte der Chemie."

On the whole, however, we can congratulate Mr. Grundy on having succeeded in explaining in clear and simple language the fundamental principles of chemical philosophy.

T. E. T.

LETTERS TO THE EDITOR

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

On Professor Tyndall's Exposition of Helmholtz's Theory of Musical Consonance

IN the course of a re-perusal of Helmholtz's "Ton-empfindungen," it occurred to me to compare the theory of consonance and dissonance, there propounded, with the exposition of that theory presented in the Lectures on Sound of Professor Tyndall. The result of the comparison is the present paper, in which I shall endeavour to show that Professor Tyndall's version of the theory is radically different from the original, and erroneous.

Helmholtz determines the consonances of two *simple* tones by reference to their combination-tones. That of the first order suffices for the *octave;* those of the first and second order determine the *fifth* and *fourth.* The remaining consonances—*major and minor sixth* and *major and minor third*, do not, according to him, admit of determination from two simple tones and their combination-tones, but require the addition of a third primary simple tone.

* "Ton-empfindungen," pp. 301-303, 306-307. I shall in the following references use "H." to denote this work, and "T." for Prof. Tyndall's lectures.

Professor Tyndall * undertakes to determine the consonances of the *octave*, *fifth*, *fourth*, and *major third* for two simple tones, without employing combination-tones. He writes as follows :—

"Bearing in mind that the beats and the dissonance vanish when the difference of the two rates of vibration is 0 ; that the dissonance is at its maximum when the beats number thirty-three per second ; that it lessens gradually afterwards and entirely disappears when the beats amount to 132 per second—we will analyse the sounds of our forks,† beginning with the *octave*. Here our rates of vibration are—

512 – 256 ; difference = 256.

It is plain that in this case we can have no beats, the difference being too high to admit of them.

"Let us now take the *fifth*. Here the rates of vibration are—

384 – 256 ; difference = 128.

This difference is barely under the number 132, at which the beats vanish ; consequently the roughness must be very slight indeed.

"Taking the *fourths*, the numbers are—

384 – 288 ; difference = 96.

Here we are clearly within the limit where the beats vanish, the consequent roughness being quite sensible.

"Taking the *major-third*, the numbers are—

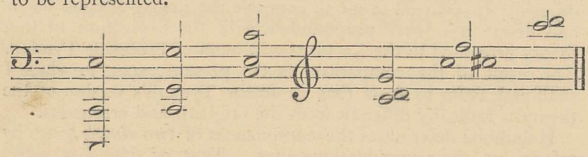
320 – 256 : difference = 64.

Here we are still further within the limit, and accordingly the roughness is more perceptible. Thus we see that the deportment of our four tuning-forks is entirely in accordance with the explanation which assigns the dissonance to beats." ‡

It will not be difficult to test the value of the above reasoning. Starting from the rate of 256 vibrations per second selected by Prof. Tyndall, all that can be deduced from his definition of beats and dissonance at the head of the extract is that the maximum of dissonance will fall on the interval 256 : 256 + 33, *i.e.* 256 : 289 ; and that all intervals larger than 256 : 256 + 132, *i.e.* 256 : 388, will be free from dissonance. These numbers indicate almost exactly a whole tone and a *fifth* respectively. Each of these results is contrary to experience: the dissonance of a whole tone is less harsh than that of a half tone ; and intervals greater than a fifth are by no means equally free from dissonance. Moreover, it follows that the determination of the octave by this reasoning is delusive, for the process would bring out, as perfect consonances, a *seventh* or a *flat ninth*, which are extreme discords, just as readily as an octave. If we apply the same method to other parts of the scale than that to which Prof. Tyndall has restricted himself, the results are even more remarkable. Thus starting from the higher octave of 256, viz. 512, the maximum roughness falls on 545, a half-tone, and dissonance ceases after 644, which lies between a *major third* and a *fourth*. For the next octave, *i.e.* starting from 1,024, dissonance ceases before we reach the interval of a whole tone. If we take lower positions on the scale we obtain opposite results. With 128 as our fundamental note, the maximum dissonance falls on 161, slightly above a *major third*, while roughness extends to 260, just beyond an *octave*.

With 64 the worst discord is at 97, just above the *fifth*, and roughness reaches 196, another *octave* higher. Starting from 32 the worst dissonance 65 is just above the *octave*, and roughness is not got rid of until 164, *two octaves and a major third* from the fundamental note.

The following octave exhibits at one view the results we have reached. The lowest note of each triad represents the fundamental note, the middle one the position of maximum dissonance, and the highest the limit of roughness. The middle note necessarily falls out of the last triad, as it lies too near the fundamental note to be represented.



Prof. Tyndall's method leads to the following conclusions :—The interval of an *octave* from the 16-foot C is the harshest possible dissonance ; so is that of a *fifth* from the 8-foot C ; so is that of a *major-third* from the lower C of a baritone voice. On the octave above the high C of a soprano voice, all the intervals beyond D are perfect consonances, while in the 16-foot octave there are no perfect consonances at all.

These conclusions are so utterly at variance with facts, that the method by which they have been obtained must be pronounced erroneous. In fact, Prof. Tyndall is himself a witness that this is so ; for, in speaking of the *octave*, he remarks that if this interval be slightly impure, *beats of the fundamental tone are heard.** Now this does not square with his own theory ; for suppose two simple tones with 513 and 256 vibrations per second, which would form an impure octave : the difference is 257, which is as much "too high" as 256 was in the case of the pure octave. This interval should, therefore, give no beats, and an impure octave be as harmonious as a pure one. But according to Helmholtz's view, the first combination-tone of 513 and 256, viz. 257, will produce one beat per second *with the fundamental tone*, as stated, but not satisfactorily explained † by Professor Tyndall. This amounts to a practical admission by him that the beats of two simple primaries are not adequate for the determination of their consonances, and that recourse must be had for this purpose to combination-tones.

I claim to have shown that the method by which Prof. Tyndall appears to determine the consonances of simple tones is erroneous, and the determinations themselves fallacious. I proceed to point out the defect which vitiates his reasoning. He enunciates but one condition for the production of audible beats, that their number should not exceed 132 per second. Helmholtz lays down a second, quite as important—that the tones producing them should not differ too much in pitch. "These beats," he writes, "are *powerful when their interval amounts to a half-tone or a whole tone, but weak and audible only in the lower portions of the scale, when it is equal to a third, and they diminish in distinctness as the interval increases.*" ‡ Here we see at once the reason why it is futile to attempt to determine consonances of a fifth or octave by the beats of two simple primaries—viz. that for these wide intervals the beats are imperceptible.

Let us now proceed to Prof. Tyndall's theory of consonance for *composite* sounds. Taking the octave C′, C″ or 264 : 528, he writes :—"With regard to the octave C′, C″, its two fundamental tones and their over-tones answer respectively to the following rates of vibration :—

		1	:	2	
Fundamental tone		264		528	Fundamental tone
Over-tones . .	1.	528		1056	
	2.	793		1584	
	3.	1056		2112	
	4.	1320		2640	
	5.	1584		3168	
	6.	1845		3696	
	7.	2112		4224	
	8.	2376		4752	
	9.	2660		5280	

"Comparing these tones together in couples, it is impossible to find, within the two series, a pair whose difference is less than 264. Hence, as the beats cease to be heard as dissonance when they reach 132, dissonance must be entirely absent from the combination. This octave, therefore, is an absolutely perfect consonance." § The same process is then applied to other intervals. For the *fifth* 264 : 396, the lowest difference between any two overtones being 132, the interval is "all but perfectly free from dissonance." For the *fourth*, 264 : 352, the least difference, 88, makes it "clearly inferior to the fifth." Similarly the *major third*, 264 : 330, with least difference 66, is "less perfect as a consonance than the *fourth*, and the *minor third* 264 : 316·8, with least difference 53, "inferior as a consonance" to all the previous intervals. ‖ In each case the "least difference" is precisely equal to the difference between the vibration-rates of the fundamental tones ; so that, in spite of the array of figures, *nothing is added by this process to that employed by Prof. Tyndall to fix the consonances for simple tones.* Inasmuch, therefore, as that method has been proved erroneous, these determinations cease to have any validity.

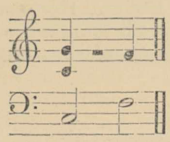
Here, again, the neglect of the second condition for the production of audible beats is at the root of the error. Helmholtz

* T. p. 296.
† Tuning-forks produce, of course, *simple* tones.
‡ T. pp. 296, 297.

* T. p. 297.
† Professor Tyndall's attempted explanation depending on *difference of phase* between the two primaries is at once refuted by the general principle that *difference of phase in partial-tones has no effect on quality*. See H. p. 193. A note and the octave above may obviously be treated as the ground-tone and first overtone of a composite sound.
‡ H. p. 302. § T. p. 299. ‖ T. p. 299—301.

does not only consider the differences of the vibration-rates of pairs of over-tones, but inquires also whether they are *within beating distance* of each other. In the former case alone can they become a source of dissonance. The interval of an *octave* is a perfect consonance, because every partial-tone of the higher sound coincides with one of those of the lower; and thus any slight deviation in pitch will produce beats between each adjacent pair.

The interval of a *fourth* is less consonant than that of a *fifth* —not, as Prof. Tyndall represents it, on account of its 66 beats which, but a single octave below that in which he has placed it, ought to become the worst possible dissonance—but because the second partial-tone of the higher sound comes within beating distance (a whole tone) of the third partial-tone of the lower, as shown on the stave—



when the fundamental tones are written in minims, and the over-tones in crotchets.

I may as well notice that a diagram given by Helmholtz * to illustrate various degrees of dissonance, and copied by Prof. Tyndall,† is accompanied by the latter with an explanation giving a wrong idea of its meaning. The diagram, as explained by its author, is intended to represent to the eye the degrees of roughness attaching to intervals greater than one octave, and not exceeding two. Prof. Tyndall having evidently missed the remark of Helmholtz ‡ that C′, *not its octave* C″, "is to be the constant fundamental tone of all the intervals," has represented the diagram as "beginning with the unison C″—C″" and going up to the octave intead of beginning with the octave C′—C″ and going up to the double octave C′—C‴. The diagram as it stands in Prof. Tyndall's lecture is calculated to convey an impression as unlike its author's meaning as it is contrary to fact.

Trinity College, Cambridge, Feb. 26. SEDLEY TAYLOR

The Valuation of Liquid Town Sewage

THOUGH I consider it highly unbecoming for one member of a committee, charged with an important inquiry, to criticise publicly and in a controversial manner, views expressed by another member of that committee in regard to the subject it has to investigate, still some of the remarks made by Mr. Hope at the Society of Arts last Wednesday seem so unmistakeably to refer to the article which appeared in NATURE on the 23rd December last, that I feel constrained, as the writer of that article, to reply to them. The statement objected to by Mr. Hope was an expression, not of individual opinion, but of the fact—long accepted as beyond question—that the practical value of liquid town sewage as manure, that is to say, its value to the farmer, cannot be computed *solely* from the amount of manure material it may contain, and that, in forming such an estimate, the positive element afforded by chemical analysis must be controlled by the negative element introduced by extreme dilution, and varying under different local circumstances. This fact has been recognised by authorities too numerous to name, and so decisively, that Mr. Hope's assertion as to the value of the ammonia in sewage being affected only in a very minor degree by the amount of water mixed with it, seems to have no other merit than that of being "sensational." I am at a loss to conceive what ground Mr. Hope could have for objecting to the statement that "it is a great mistake, and likely to prove a very ruinous one," to estimate the value of dilute sewage by calculation solely from the amount of manure material it may contain. Yet this is what Mr. Hope characterises as a "strange paradox." Why it has puzzled him, as he admits, I will not stop to inquire; but I must protest against his representing "the obligation of applying water to crops at all times of the year, whether they want it or not," as having been one of the reasons given for the statement he objects to. In doing that he has at least fallen into a great error, and he has at the same time evaded the point to which attention was directed in the article, viz., the agricultural difficulty attending the "continuous daily application of sewage to land." That is a difficulty not to be disposed of *ex cathedra*—it would obtain whether the land destined to receive sewage were under crops or lying fallow. In the one case the application of sewage might be inadmissible during great part of the year; in the other case the land under fallow would be unproductive meanwhile. Indeed the need for applying sewage to fallow land, which Mr. Hope seems to suggest, would enhance the difficulty of disposing of sewage by irrigation, since it would involve the want of a still larger area of land for its reception, day by day throughout the year. Such a mode of application might well necessitate an area of twenty-five acres for every 100 persons, and that necessity, if it existed, would be, I imagine, a very serious matterin the case of many towns.

I will not attempt to occupy your space by considering the question whether leaving land under fallow is to be regarded as a feature of progress in agriculture; nor will I venture an opinion as to whether water be the "best dung-cart," further than to express my surprise that, in regard to this question, Mr. Hope should have recourse to a chemist's opinion while declaring that its decision is not within the province of the chemists.

The case put by Mr. Hope, with an air of anticipatory triumph, of a man who applies to his land an excessive and useless amount of manure, seems to me an exact parallel to the use of liquid sewage in many instances, for whether it be the fancy or the folly of the farmer, or some other circumstance, which impels him to use manure in such a way that the possible effect cannot come up to the amount of manure applied, I should imagine it to be obvious that, to the user, the value of the manure must be gauged by the practical effect likely to be realised. I should expect this view to be appreciated even by the bucolic intellect which Mr. Hope seems disposed to contemn.

As stated by the chairman at the Society of Arts meeting, the views held by Mr. Hope on the general subject of town refuse are clear and precise. There is no doubt what those views are, but it is not my intention to enter upon any discussion of them. At the same time, as a member of the British Association Committee, and having individually entertained the expectation that Mr. Hope's co-operation would be of material service in the inquiry it has to make, I cannot avoid expressing my regret that he declares himself a partisan of one particular solution of the town-refuse problem. There are, probably, few questions of the day which demand more careful and impartial consideration than this one—few that less admit of being dealt with for the promotion of a project at any price. For my own part, therefore, I deem it a misfortune that the value of Mr. Hope's well-known ability and extensive knowledge of this subject should be limited by his avowal of a foregone conclusion.

February 28. BENJAMIN H. PAUL

Weeds in Newly Turned Ground

FROM a recent address of Mr. Bentham, the President of the Linnæan Society, it would appear to be still uncertain whether the weeds which appear spontaneously on ground which has been newly turned over, spring from seeds hidden in the ground, or from seeds accidentally carried on to the new surface. Could not this question be decided by a simple experiment, namely, by turning over some suitable ground and covering parts of it by gardener's glass frames, so as to prevent the importation of any seeds? So far as the weeds are the same both within and without the frames, it is certain that they must spring from seeds previously contained in the earth. It is true that there will be a difference of temperature beneath the glass and in the open air, but it would not prevent us from learning what seeds are really contained in the earth. A frame covered with fine muslin would serve instead of glass if the muslin be fine enough to prevent the passage of any seeds.

J.

Skeleton Lectures on Science

I HOPE you will allow me, through your valuable pages, to suggest what I have no doubt would be a most powerful and successful means for promoting scientific knowledge throughout the length and breadth of the land. There are hundreds of persons with the desire and a sufficient taste and general knowledge of science, who now devote themselves to penny readings, who would be too glad to give popular lectures on scientific subjects, if they could only be aided by *skeleton lectures*, and the loan, on moderate terms, of simple apparatus, diagrams, &c., to illustrate the same. It certainly would well remunerate any scientific instrument maker to loan out apparatus for such lectures.

Skeleton sermons are enormously in request, why not skeleton lectures on science? W. L.

* The second on page 292. † Page 208. ‡ Page 291.

ANCIENT BRITISH LONG BARROWS

I.

THERE are many hopeful signs that the number of persons to whom all knowledge of nature is dear for its own sake is steadily on the increase ; but it is, unfortunately, true that science still requires some adventitious aid to secure the attention of the general public. We must, therefore, look upon it as a matter of congratulation that even the Irish Question has been found to have a scientific aspect, and has recently awakened some general interest in so obscure a subject as that of the ethnology of England and Ireland.

It is not our present intention to enter upon the long-standing controversy as to the physical characters of the so-called Kelts, as we think that the materials for a satisfactory solution of the various questions involved are still very insufficient, notwithstanding the large amount of really trustworthy evidence collected of late years by Broca, Pruner Bey, and others in France, and by Barnard Davis, Thurnam, Beddoe, and Wilson in our own country. Few persons have any idea of the time, skill, and patience necessary for any satisfactory investigation either of the ethnic composition of existing populations, or of the characters and affinities of the earlier races whose works and remains have come down to us. It may seem surprising that we should be long in doubt on matters apparently so easily settled as the average stature, prevailing head-form, and distribution of colour of hair and eyes, in various districts of our own and neighbouring countries ; but it must be remembered that the number of persons interested in this branch of inquiry is extremely small, and that the collection of anthropological statistics by inaccurate or improperly instructed observers is very much to be deprecated. If the scientific study of existing populations is surrounded with difficulties and can reckon but few votaries, still more is this the case with the investigation of the character and affinities of the races inhabiting Western Europe at the dawn of history and in pre-historic times. We have had innumerable riflers of grave-mounds and endless discussion of the scraps of information handed down by Greek and Roman authors ; but of thorough and extended investigation of pre-historic monuments of any one class or of any given district, with a view to elucidating the ethnography and early history of the country rather than with the object of collecting specimens for the museum, we have all too little to show.

The late Mr. Bateman devoted considerable attention to the pre-historic archæology of Derbyshire and the adjoining counties, but his extensive investigations do not appear to have been conducted with the care or described with the accuracy necessary for scientific purposes. The important researches for remains of our early ancestors, made by Sir Richard Hoare and Mr. Cunnington in the richest district in all England, were undertaken so long ago as the beginning of the century ; and although the explorations are recorded in full detail in Sir Richard's great work, "Ancient Wiltshire," the general results have not hitherto been fully and satisfactorily worked out. This want has, however, at length been supplied in a memoir* recently communicated to the Society of Antiquaries by Dr. John Thurnam, a gentleman who possesses the rarely combined qualifications of classical scholarship, antiquarian knowledge, and familiarity with scientific method, and who is well known as one of the authors of the "Crania Britannica," undoubtedly the most valuable contribution to the ethnology of this country which has yet been published. The memoir in question is not a mere analysis of the labours of the Wiltshire baronet and his coadjutor; it is to a large extent a record of original explorations, more especially of a class of monuments somewhat neglected by Sir Richard Hoare, but to which the greatest interest attaches now that the advances in certain departments of anatomical knowledge enable us to turn to due account the evidence afforded by human remains.

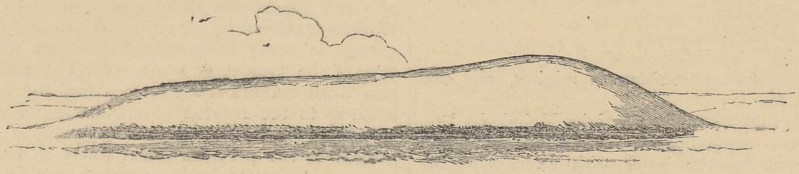


Fig. 1.—A Long Barrow (after Sir Rd. Hoare)

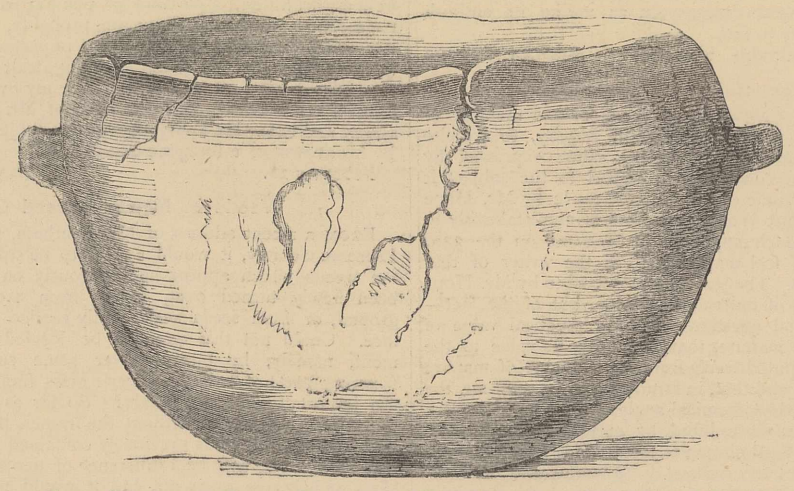


Fig. 2.—Vessel with Primary Interment. Norton Bavant, Long Barrow (scale ⅜ linear)

* On ancient British Barrows, especially those of Wiltshire and the adjoining counties. Part I. Long Barrows. From the "Archæologia," vol. xlii, 1869.

The monuments to which we refer are the huge grave-mounds known as Long Barrows, and chiefly occurring in Wiltshire and the adjoining counties.

Only the first part of Dr. Thurnam's memoir has as yet been published—that, namely, relating specially to the Long Barrows ; but this part is of sufficient importance to demand separate notice at our hands.

The chief result of the examination of the Ancient British barrows of the south-west of England is their division into two great classes—(1) the Long Barrows, the primary interments of which have yielded implements of stone and bone only, and which are, therefore, confidently assigned to the Stone Age ; and (2) the Round Barrows, affording implements of bronze as well as of stone, and occasionally, though rarely, of iron. The round barrows vary considerably in form, and Dr. Thurnam thinks that these variations are not to be attributed to the individual fancy of the builders. He recognises three primary forms of round barrow—the bowl-shaped, the bell-shaped, and the disc-shaped ; each of these three having again its three modifications. The long barrows are of two kinds —the simple barrows of South Wilts and Dorset, consisting merely of earth, chalk, and flints ; and the barrows of North Wiltshire, Gloucestershire, and Somersetshire, containing chambers or cists built of large stones.

Wiltshire is, *par excellence*, the county of long barrows, one district consisting of about 150 square miles, containing, on an average, one of these huge mounds in every six miles. The distribution of these monuments is a point of great interest. Unlike the round barrows, which usually occur in clusters, they are almost without exception solitary—generally two or three miles apart—and situated in some prominent position, usually the highest points of the hills, commanding extensive views over the downs. The immense size of the mounds of the South Wilts and Dorsetshire long barrows, and the imposing stone structures of those of North Wilts, Gloucestershire, and Somersetshire, would alone be sufficient, notwithstanding the rude character of the implements contained in them, to lead one to conclude that we have here the graves of the chieftains of the primitive people of these districts. The situations chosen for the grave-mounds, and the evidence, hereafter to be alluded to, of the immolation of slaves, and perhaps wives and children, seem strongly to confirm this supposition.

It will be convenient in the remainder of our notice to treat separately of the unchambered and chambered barrows; that arrangement having been followed in the memoir in the "Archæologia." The following is Dr. Thurnam's account of the external form of the simple or unchambered barrows :—"The long barrows are for the most part immense mounds, varying in size from one or two hundred to three and even nearly four hundred feet in length, from thirty to fifty feet in breadth or upwards, and from three to ten or even twelve feet in elevation. (See Fig. 1.) Along each side of the whole length of the tumulus is a somewhat deep and wide trench or ditch, from which trenches no doubt a great part, or sometimes even the whole, of the material of the mound was dug, but which it is very remarkable are not continued round the ends of the barrow. . . . . In by far the greater proportion of long barrows the mound is placed east and west, or nearly so, with the east end somewhat higher and broader than the other. Under this more prominent and elevated extremity the sepulchral deposit is usually found at or near the natural level of the ground." The great infrequency of manufactured objects in these barrows and their rude character is very remarkable. Some "delicate

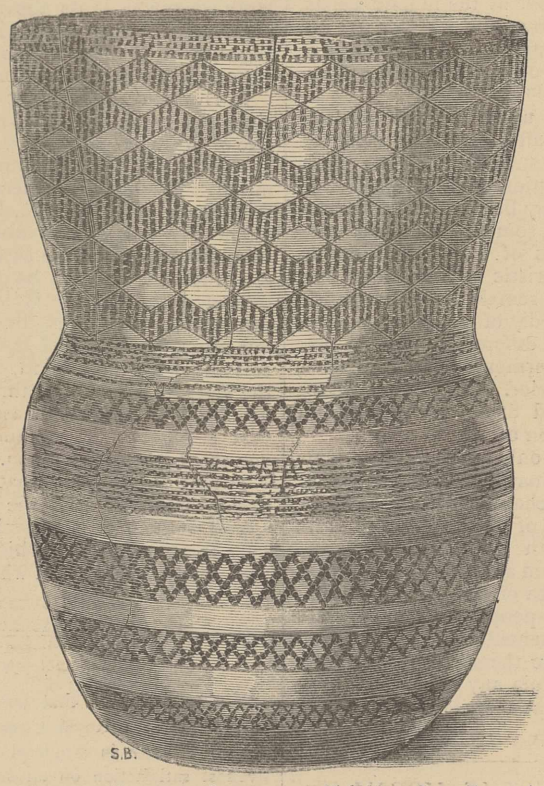


Fig. 3.—Drinking Cup with Secondary Interment. Figheldean, Long Barrow (scale ½ linear)

and beautifully-chipped leaf-shaped arrow-heads" have been found in one or two instances, and this type of arrow-head, which is unbarbed, is the only one yet discovered. In no case has any trace of metal been found with the primary interments. Fragments of a coarse black pottery are occasionally met with, and in one barrow, that of Norton Bavant, Dr. Thurnam was fortunate enough to discover a tolerably perfect vessel of extremely rude construction, and utterly devoid of the ornamentation usually found in the pottery from the round barrows. Thanks to the courtesy of the Society of Antiquaries, we are enabled to reproduce Dr. Thurnam's drawing of this vessel. We are likewise indebted to the same Society for the other figures which illustrate this paper.

Remains of oxen of the ancient small species, *Bos longifrons* or *Bos brachyceros*, are often found in long barrows not far from the human remains; antlers and bones of the red deer are still more frequent. Tusks and bones of swine have also been discovered. It would appear that oxen were slaughtered at the funeral feasts, and that the heads and feet (the bones of which parts are more frequently found), not being used for food, were buried in the barrow, perhaps as offerings to the gods or to the spirits of the dead.

Secondary interments in the upper portion of long barrows are not infrequent, and afford valuable evidence of the antiquity of these tumuli. Some of these interments are assigned without hesitation to the Anglo-Saxon period; others, again, undoubtedly belong to the Ancient Britons of the bronze age, being sometimes burials after cremation, sometimes interments of entire skeletons in the contracted posture characteristic of the round barrows. In the latter case the remains are frequently associated with pottery undoubtedly of the round-barrow period. In order to show the difference between this pottery found with secondary interments in long barrows, and part of the long-barrow period itself, we reproduce (Fig. 3) an elegantly ornamented drinking-cup found at Figheldean, and now in possession of Dr. Thurnam.

In the present article we have only touched upon some of the most interesting of Dr. Thurnam's researches. It still remains for us to notice the chambered long barrows, and the most important evidence of all, that derived from the skeletons disinterred in both chambered and unchambered barrows. We have been able from the archæological evidence to gain some idea of the state of barbarism in which these primitive people lived; but still further information is to be obtained even on this point from the very bones of the people themselves; and from these sad relics alone can we obtain any ray of light as to the relation of these most ancient Britons to the population of more civilised times.

HOW LARGE SEEMS THE MOON?

IN a communication addressed to the Association Scientifique, M. Viguier remarks on the linear dimensions which ordinary observers employ to define the size of celestial objects. They seem to imagine that they are really pointing out the size of a meteor, for instance, when they state that it was a yard in diameter, or the like. Of course, such a statement is absolutely without meaning to the astronomer; while the seemingly less precise mode of speaking which compares the size of a meteor to that of the moon, is in reality much more valuable. It is true that when an observer says a meteor was as large as the moon, he makes a wider error than when he says it was a yard in diameter; but the astronomer knows what one statement means, whereas he can form no real estimate even of the meteor's apparent size from the other.

If every observer formed the same estimate of the linear dimensions of a celestial object, one might indeed interpret a statement of the linear dimensions of a meteor. But this is not the case. As M. Viguier justly remarks, the short-sighted or the far-sighted person each forms his own estimate of the moon's real size, the position of the moon affects the judgment, nay, even the state of the weather influences our instinctive estimate.

But it is interesting to consider what is really implied by such a statement as that the moon is a foot in diameter. This is a size often assigned to the moon, I may remark, though many judge her to look larger. The moon subtends an angle of about half a degree, so that this estimate makes half a degree of the celestial sphere one foot in length. Thus the circumference becomes about 720 feet, and the radius about 115 feet. This, at any rate, is the distance which the estimate assigns to the moon. And this last view is the more correct, since the varying estimates made of the moon's dimensions according to her position, suffice to show that the mind instinctively assigns to the celestial vault a somewhat flattened figure, the part overhead seeming nearest to us. In fact, a common opinion that the moon's diameter looks about twice as large when she is on the horizon as when she is nearly overhead, would assign to the celestial dome the figure of a segment of a sphere, less than a fifth of the sphere's surface being above the horizon.

It is worth noticing, though M. Viguier does not consider the point, that we can conclude from the estimated size of the moon *as compared with the intervals separating certain stars*, that the mind intuitively assigns to the moon a distance considerably greater than that of the fixed stars. For example, I find that if, when the moon is below the horizon, an observer be asked whether the distance separating the three stars in Orion's belt (ζ from ϵ, or ϵ from δ, I mean) be greater or less than the moon's diameter, the answer is that it is about equal to that dimension. In reality, the moon's apparent diameter is but about one-third of the distance between these stars. It follows that the mind estimates the distance between the stars on a scale one-third only even of the small scale according to which it measures the moon; in other words, that it regards the distance of the fixed stars as about one-third that of the moon.

It may be, however, that the result of this comparison merely indicates that the mind assigns to the celestial sphere as seen on a moonless night a distance equal to only one-third of that which separates us from the faintly seen stars of a night on which the moon is full.

RICHD. A. PROCTOR

NOTES

WE are informed that her Majesty's Government has determined to issue a Royal Commission to inquire into the present state of Science in England. This step will be hailed with the liveliest satisfaction on all sides, and much good will certainly follow from such an inquiry, especially at a time when the arrangements for the prosecution of Science in this country are acknowledged on all hands not only to be "chaotic," but positively detrimental to the national interest. We learn that some of the commissioners have already been designated, but as their number is not yet complete, we withhold the names.

WE have been favoured with a copy of the report just issued by the Rivers Pollution Commissioners on the Mersey and Ribble basins. We hope to return to this subject shortly.

THE first Royal Society's Soirée of this Session will take place on Saturday evening next.

MR. E. RAY LANKESTER has been elected by examination to the Radcliffe Travelling Fellowship at Oxford.

WE have received the third part of Vol. I. of the Transactions of the Edinburgh Geological Society, containing the communications made to that body during its session 1868-1869. These are numerous, and testify to the activity of the members of the

society. The most important are Mr. Powrie's description of the fish remains of the Old Red sandstone rocks of Forfarshire; Mr. Robert Brown's paper "On the geographical distribution and physical characteristics of the coal-fields of the North Pacific coast;" and Mr. Croll's notice of two river channels buried under drift. Mr. Powrie's paper is illustrated with five plates of roughly executed, but tolerably characteristic figures. The part also contains a biographical notice of the late Prof. J. D. Forbes.

The American Gaslight Journal and Chemical Repertory states that Professor Loomis, who claims to have discovered a way to transmit messages by electrical air currents without the aid of wires, wants to be appointed Consul to some European port, that he may experiment on the summit of Mont Blanc.

FOR many years it has been a query whether the electric current might not be brought so far under man's control as to take the place of steam as a motor for machinery, and success has at last crowned the persevering efforts of scientists. At the last exhibition of the American Institute, there was seen an elliptic lock-stitch sewing machine, driven by a small electric engine which might easily be put into a common hat box. A series of eight magnets are set on the periphery of a circle, and around these revolves an armature of steel, which is continuously propelled by the magnetic action, and thus operates the machinery that moves the needle. Connection with this motor is had by means of a small slide within easy reach of the operator, at whose will the current may be cut off entirely, or the speed of the needle graduated as may be desired. The use of this motor, if it becomes general, eannot fail to prove of the utmost benefit to ladies, especially to machine operators, as it does away entirely with the necessity for using the feet, as is now the case, and must be highly conducive to the health of females, who suffer from many diseases that are generated by the constant strain on the pedal and limb muscles. The inventor of the engine in question is Charles Gaume.

A LARGE chemical laboratory is projected at Harvard. The library building is also to be greatly enlarged.

WE regret to learn that a wing of the Emperor's Palace in Pekin has been burned, containing the Imperial printing-office, with large stores of books and block-types. The books printed at the Imperial cost for the last two centuries have issued from this printing office.

Prof. W. H. Miller, of Cambridge, has been elected a correspondent of the French Academy of Sciences, in place of Prof. Fournet, of Lyons. The other candidates were MM. Abich; G. Bischoff; A. Boué; Dana; v. Dechen; Domeyko; J. Hall; v. Hauer; v. Helmersen; C. T. Jackson Kjerulf; v. Koksharow; F. Romer; Scacchi; A. Sismonda; Studer, and Sir W. Logan.

THE Cleveland correspondent of the *Engineer* states that operations are in progress for working upon a large scale the salt deposits underlying Middlesborough.

WHATEVER may be the case in our own country, it is gratifying to see that there exists in France considerable sympathy between scientific and literary men. Professor Sars, the late eminent zoölogist at Christiansen, left a large family in very impoverished circumstances; and an appeal for their relief was made in our columns by Mr. Gwyn Jeffreys, from his personal knowledge of the case, to the naturalists and geologists of Great Britain. This appeal was seconded in France by M. Alglave, in his *Revue des Cours Scientifiques;* and the result has been highly successful in both countries. It must tend to foster and increase the sentiment allied to that of freemasonry which animates men of science everywhere without regard to nationality. But in France this charitable movement has not been confined to scientific men. M. Emile Girardin, in *La Liberté*, has advocated it with his usual ability and energy; and in the list of French subscribers to the fund are the names of his Excellency M. Segris, the Minister of Public Instruction, M. Villemessant, the Chief Editor of *Figaro*, Alexandre Dumas, fils, the Society "des amis des lettres" at Paris, the Stanislaus Literary Society at Nancy, Clery the painter, *L'Echo de la Sarbonne*, and many others of a similar kind. Let us hope that science, arts, and letters may be associated here also on the same friendly footing, each promoting the objects of the other, and all working together although placed in different grooves of the machine.

AT the annual general meeting of University College, London, Mr. George Grote presided, and the following students of the College, who had "passed distinguished examinations for University degrees," some at London alone, others at Cambridge as well as at London, were admitted Fellows of the College on the nomination of the Council:—in Arts, Mr. Numa Edward Hartog, Mr. Alfred Slater West, Dr. Richard Francis Weymouth, and Mr. Augustus Samuel Wilkins; in Medicine or Science, Dr. Henry Charlton Bastian, Mr. Marcus Beck, Dr. Frederick George Finch, and Dr. Edward Lloyd Harries Fox.

DR. J. H. GLADSTONE will bring the subject of "Indices of Refraction" before the next meeting of the Chemical Society.

THE Board of Trinity College, Dublin, has nominated the Rev. T. Leslie, F.T.C.D., to the Professorship of Natural Philosophy in Trinity College.

THE President, vice-Presidents, and Committee of the Quekett Microscopical Club have issued cards for a conversazione on Friday evening the 11th, at eight o'clock.

WE learn with much regret that the celebrated botanist, Prof. Fr. Unger, died suddenly on February 13th, at Gratz.

WE hear that the number of candidates for the place of Assistant-Registrar about to be created at the University of London is very great. Among them are men of high position and attainments, who are perhaps desirous to obtain a footing in London. They will know their fate ere long, for the choice of the Senate is to be made in the course of this month.

WE hear that the "Ladybirds" which excited so much curiosity last autumn, have reappeared in large numbers in the neighbourhood of New Wandsworth. So early an appearance will surprise most of us who have been wont to regard these visitors as summer guests.

WE learn from the *Athenæum* that the Société de Géographie has awarded the Empress's new prize of 10,000 francs to M. de Lesseps, and that he has given the money as a contribution to the Society's projected expedition into equatorial Africa.

THE *Pall Mall Gazette* reports that all the medical men connected with the case of the Welsh fasting girl were to appear last Monday before the justices at Llandyssil, to answer the charge of "wilfully killing and slaying" Sarah Jacobs, the prosecution being instituted by the Government.

NOTICE is given that at the annual election of fellows to be held in October next at the University of Cambridge, one fellowship will be given for proficiency in the natural sciences. The examination will be held in the latter half of the month of September, on days hereafter to be fixed. The subjects for examination will be those appointed for the natural sciences tripos. The competition for this fellowship will be open to any member of the University who shall have attained the degree of B.A., B.L., or M.B., and whose standing after such degree shall not exceed three years.

WE have received from the Canadian Government Emigration Office the Year Book and Almanac of Canada for 1870, containing statistics and other useful information relating to British North America, and a map showing the railways and their principal connections.

THE current number of the *Revue des Cours Scientifiques* contains a translation of Mr. Carruthers' lecture at the Royal

Institution, on the Cryptogamic forests of the coal period, and a continuation of the report on the Anthropological Congress at Copenhagen.

Cosmos states that the cavern of Montesquieu-Avantès (Ariége) has been recently explored by M. F. Regnault, of Toulouse, who discovered, on the surface of a hearth covered with stalagmite, bones of ruminants and human bones, the latter consisting of fragments of skulls, leg and arm bones. The whole were sent to M. F. Garigou, who declares that both kinds of bones are broken in the same manner, and each bears indications of a smashing instrument and of a sharp tool that has scratched them. These bones are said to be exactly similar to those which were regarded as furnishing decided proof of cannibalism, at the Anthropological Congress in 1867. M. Garigou writes that he has no hesitation in agreeing with MM. Spring, Dupont, Schaffausen, Broca, Carl Vogt, Steenstrup, &c., that primitive man was, like modern savages, anthropophagous.

Les Mondes also reports that Prof. Capellini of Bologna, has discovered remains of man and of animals in a cavern in the island Galmeria, the access to which is difficult and dangerous. In excavating he found many implements of flint and stone, the working of which showed that they belonged to the most remote stone age. Besides objects referrible to the hand of man, he found many which had been carried there by the human inhabitants of the cave, and a considerable quantity of animal bones, mixed with the human bones. The condition of the latter indicated that the cave had been inhabited by cannibals. At the centre of the cave were traces of a hearth.

Dr. Bertholle has communicated to the Société Médico-Chirurgicale the particulars of what he believes to be a case of spontaneous combustion, which recently came under his notice, the subject being a woman who was an habitual spirit drinker frequently suffering from *delirium tremens*.

The *Siècle* states that M. Combes has declined to act on the commission charged with the temporary direction of the Paris Observatory, and that his place has been filled by M. St. Claire Deville.

We have received the prospectus of a new series of the "Zeitschritt für die gesammten Naturwissenschaften," edited by Dr. C. G. Giebel and Dr. M. Siewert, of Halle. One of the main features of the journal is to be the publication of monthly reports of the progress of astronomy and meteorology, physics and chemistry, geology, mineralogy, palæontology, botany, and zoology.

Cosmos reports the death of M. Florent Prevost, assistant-naturalist at the Museum of Natural History, and known for his useful work in connection with the agronomic applications of zoology.

We have received from the Chairman of the Technological Commission of Victoria, a report on the promotion of technical and industrial instruction, by lectures and otherwise, among the working classes of Victoria.

The Food Committee of the Society of Arts had recently before them a specimen of meat treated by Professor Gamgee's process. A joint of mutton—stated to be part of a sheep slain on December 28th, and to have been, since the treatment, simply hung up in Professor Gamgee's premises—was roasted and tasted by the Committee, who pronounced it very satisfactory; but the Committee considered that a test over a longer time and at a warmer period of the year, was necessary before any decided opinion as to its success could be given. Another joint—from a sheep slain on the 22nd December—was ordered to be placed in charge of the Secretary, to be tested at a future time. Mr. Tallerman also exhibited specimens of meat imported from Australia, and showed it both cooked and uncooked. He explained the plan he had adopted, by means of which cheap dinners were prepared from it for the use of the people. Specimens of raw meat from Australia, preserved in tins by Manning's process, were brought before the Committee. The meat consisted of beef steaks, which were cooked and tasted by the Committee. The meat, though sound, was not considered satisfactory in flavour.

Cosmos reports the death of M. Foucou at New York, shortly after establishing himself at Oil Creek, where he intended to carry on the working of petroleum, to the industrial application of which he had given much attention.

Mr. Hartnup, astronomer at Liverpool, has published his annual report to the Marine Committee Mersey Docks and Harbour Board, and is no doubt not a little gratified at dating it from a new Observatory. The old building having been swept away by dock improvements, a new site was found on the left bank of the river, on the top of Bidston Hill, about a mile to the rear of Birkenhead Docks, and two hundred feet above the mean sea-level. The new building occupies about five hundred square yards in an acre of land set apart for the use of the Observatory. Underground rooms, with arrangements for elevating the temperature at pleasure, are provided for the testing of nautical instruments. In each hot-air chamber one hundred chronometers can be placed at once for examination. Two octagonal, domed rooms, twenty feet in diameter, rise at opposite angles of the building, one being occupied by the transit, the other by the equatorial instrument. In the words of the report, "The site is remarkably favourable for astronomical and meteorological observations." We may, therefore, hope to hear of much good work being accomplished at the Liverpool Observatory. To facilitate comparison of chronometers without the trouble of carrying them to the Observatory, a time-gun has been placed on the river brink near the landing-stage at Birkenhead. This gun is fired every day at one o'clock by a galvanic current sent from the standard clock on Bridston Hill, and masters of vessels lying in the port thus get the true time. Besides the observations of transits required for the service of the establishment, the usual meteorological observations have been taken, comprising daily and hourly readings of the barometer, the velocity and direction of the wind, the amount and duration of windfall, and the mean daily temperature of evaporation. All these results, collected into tables, are published at the end of the report, and thereby add to its utility. The site of the old Observatory was in latitude 53° 24′ 48″ N., and longitude 3° 0′ 1″ W. from Greenwich: the new Observatory is 17·04 seconds farther to the west.

According to the Sydney Correspondent of the *Times* the production of sugar in Australia appears to be progressing rapidly and successfully.

We learn from the *Society of Arts Journal*, that at a recent meeting held at the Town Hall, Reading, it was decided to accept the offer made by the Hon. Auberon Herbert, and to establish a free library.

For many years past the French physician, M. Burg, has been engaged in investigating the effect of copper as a preservative and curative agent in cholera. In support of his theory, M. Burg instances the immunity enjoyed by workers in this metal from cholera. He has obtained from the Prefect of the Paris police, certain statistics which go to prove that this immunity in the case of copper-workers has a real existence. In the instances of jewellers, engravers on metal and clockmakers, out of a population of 11,500, there were 16 cases of cholera, or 1 in 719. Engravers in copper, makers of metal eyelet-holes, jewellers working with copper, had, in a population of 6,000, 6 cases, or 1 in 1,000. Founders, tap-makers, chisellers, turners in bronze, lamp-makers, and workers in counterfeit gold, had, in a population of 14,000, 7 cases, or 1 in 2,000. Opticians using copper, mathematical instrument makers, musical instrument makers, stampers, metal polishers, &c., out of a population of 5,650, had not a single case of cholera.

BOTANY

Movements of Chlorophyll

ACCORDING to observations recently made by the French botanists, MM. Prillieux and Roze, the grains of chlorophyll in the leaves of plants assume different positions according as they are exposed to light (either natural or artificial) or to darkness. In darkness these grains, together with protoplasmic threads to which they are attached, are in contact with the walls which divide the cells from one another; under the influence of light they gradually change their position from these to the upper or under walls which form the surfaces of the leaf. M. Roze believes that this motion originates in the protoplasmic threads, which are the vital and animating part of the cell. (*Comptes Rendus.*)

Dependence of the Distribution of Plants on that of Animals

PROF. HILDEBRAND continues in the *Botanische Zeitung* his account of Delpino's investigations on the Dependence of the Geographical Distribution of Plants on that of Animals (see NATURE, No. 9, p. 246). In passing from the tropics to the temperate regions, we observe a general falling off in the number of species of native plants, caused by the disappearance of those animals which are needful for their fertilisation. Thus a large number are lost whose impregnation depends upon humming-birds. Roses and pæonies disappear where the larger Coleoptera are no longer found. The greater number of *Sileneæ*, and especially the night-flowering species of *Silene* and *Lychnis*, find their limits where nocturnal Lepidoptera cease. In the Arctic zone those plants only can be found which are fertilised by the agency of Hymenoptera, Diptera, or the wind. This law is illustrated by the flora of Nova Zembla lying between 71° and 76° N. lat., and Spitzbergen, between 76° and 80° N. lat. Out of 124 species of flowering plants constituting the phænogamous flora of Nova Zembla, six belong to the tribe *Pedicularineæ*, which are neither self-fertilised, nor by the agency of the wind, but entirely by the help of Hymenopterous insects. The inference is drawn that, notwithstanding the severity of the climate (the mean temperature of August, the hottest month in the year, not rising above 5° C. or 41° F.), some insect of this class must find its home there. Accordingly Spören records observing a single beetle and a ground-bee, with a few flies and midges. The insect described as the ground-bee is probably the widely-diffused *Bombus terrestris*, one of the most active of insects in the fertilisation of plants. Prof. Delpino thus classifies the 124 flowering plants of Nova Zembla: 16 dichogamous, fertilised by Hymenoptera; 84 dichogamous or homogamous by Hymenoptera or Diptera; 24 dichogamous by the wind. Out of 91 flowering plants found in Spitzbergen, 2 may be described as fertilised by Hymenoptera, 63 dichogamous or homogamous by Hymenoptera or Diptera, and 26 by the wind. In neither country are there any plants dependent on Lepidoptera for their fertilisation. A. W. B.

M. JOSE DI CANTO has successfully introduced, on an experimental scale, the cultivation of *Cinchona officinalis* into the Azores.

SCIENTIFIC SERIALS

The last number of Poggendorff's *Annalen der Physik und Chemie* (vol. cxxxviii. part 4), contains the following papers:—(1.) "Thermo-chemical Investigations, Part iii." by Julius Thomsen (pp. 497 to 514). This communication relates to the calorimetric behaviour of the acids of sulphur and selenium when neutralised with bases. The author's numerical results differ considerably from those of Favre and Silbermann. This difference is ascribed by him to the use, by those investigators, of the mercurial calorimeter, which he considers to be "altogether inapplicable for accurate determinations." (2.) "Mineralogical Communications" (ninth part), by G. vom Rath (pp. 515 to 550). (3.) An addition to a previous communication "On the crystalline forms of salts of certain sulpho-acids derived from phenol," by the same author (pp. 550 to 553). (4.) "Experiments on Irradiation," by Wilhelm von Bezold (pp. 554 to 560). This paper contains a description of experiments whereby the imperfect achromatism of the eye is made strikingly evident, and also of a method of producing analogous effects objectively upon a screen by means of a simple unachromatised convex lens. (5.) "On the vibrations of a plate of air corresponding with those of a solid plate," by E. H. Vierth (pp. 560 to 563). Two Chladnis plates were fixed by means of a clamp parallel to each other, and one about a millimeter above the other, a disk of cork being placed at the centre to prevent them touching. The upper plate being thrown into vibration by means of a fiddle bow, the distribution of nodes and loops in it and in the stratum of air between the plates, was ascertained by strewing sand upon each plate. The sand figures formed, respectively, upon the upper plate by its own vibrations and upon the lower plate by the vibration of the stratum of air, were markedly different, but, nevertheless showed a distinct correspondence. (6.) "On the corrosion-figures and asterism of Iceland spar," by Heinrich Baumhauer (pp. 563 to 565). (7.) "Reply to the critical remarks of Mr. L. Boltzmann," by R. Most (pp. 566 to 570). In this paper, which is entirely mathematical, the author maintains the accuracy of a demonstration of the second fundamental theorem of the mechanical theory of heat communicated by him to a previous number of the *Annalen*. (8.) Experimental investigation into the influence of temperature on electromotive force," by L. Bleekrode (pp. 571 to 604). Solutions of salts of various metals were placed between precisely similar electrodes of the same metal in each case as that contained in the salt employed, and the electrodes were connected by a metallic circuit of great resistance, containing a delicate reflecting galvanometer. When the liquid in contact with one of the electrodes was heated, a current was obtained in most cases of such a strength as to indicate a change of electromotive force between the metal and liquid approximately proportioned to the change of temperature. The experiments seem to show that the currents observed were of the nature of thermo-currents, but they are not quite conclusive on this point. (9.) "On new Sulpho-salts" (third communication), by R. Schneider (pp. 604 to 628). (10.) "Experiments on combinations of Mica" (from the Proceedings of the Berlin Academy, July 1869), by E. Reusch (pp. 628 to 638). If a number of thin plates of biaxal mica are superposed, so that the principal section of each makes an angle of 60° with that of the preceding one, the combination has the optical properties of a uniaxal crystal causing rotation of the plane of polarisation to the right or left, according to the direction in which each plate of mica is turned relatively to the preceding one. (11.) "On the separate perception of an Over-tone simultaneously with the Fundamental tone," by C. B. Greiss (pp. 638 to 640). This paper contains nothing new, except that it ascribes to Prof. Tyndall a well-known experiment of Helmholtz's. (12.) "Reply to Dr. Mohr," by A. Von Lasaulx (pp. 640 to 642), respecting the formation of basalt. (13.) "On the motion of the light of the negative inductive discharge in rarefied air," by J. C. Poggendorff (pp. 642 to 644). When the discharge of an induction coil is allowed to pass between two fine platinum wires, the ends of which are within one millimetre of each other, the well-known negative glow recedes from the end of the negative wire, in proportion as the air in which the discharge is taken is more and more rarefied; and at the same time the position of the greatest evolution of heat by the negative discharge recedes similarly.

The Ibis, a quarterly journal of Ornithology, New Series, No. 21, January 1870. (Van Voorst.) The papers contained in this number are—(1.) "Notes on the Birds of the Peninsula of Sinai," by C. W. Wyatt. (2.) "On the Sun-birds of the Indian and Australian regions," by Lord Walden—an article showing an extraordinary acquaintance with the literature of the subject. (3.) "On a fourth collection of birds from the Fantee country," by R. B. Sharpe. (4.) "A list of the birds of Turkey," by Captain Elwes and Mr. T. E. Buckley—the first attempt at a compilation of all the available information respecting the ornithology of one of the least known European countries, including that acquired by the authors during a tour through various parts of the Turkish dominions. (5.) "On the Ornithology of Hainan," by Consul Swinhoe, hitherto well known by his successful researches in the sister island of Formosa—an article containing results quite as remarkable as those furnished by the writer's former explorations. (6.) "Notes on the birds of the Island of St. Helena," by J. C. Melliss. (7.) "Additional notes on Mr. Lawrence's list of Costa-Rican birds," by O. Salvin. (8.) "Notices of recent Ornithological publications," English, German, Finnish, Italian, Portuguese, and Australasian, wherein more than thirty works are briefly reviewed; and (9.) "Letters from Mr. Allen Hume, Drs. Jerdon and Malmgren, Captain Shelley, Messrs. Gurney, Harting, and Sharpe, Dr. Salvadori and Mr. Swinhoe." The number also contains four well-drawn and coloured lithographic plates, by Mr. Keulemans, representing seven species of birds, all but one hitherto unfigured.

STAR-DRIFT

WITH reference to the accompanying account of my paper on this subject, recently communicated to the Royal Society, it is to be remarked that the interest, if any, attaching to my results must be founded on the way in which they bear on received theories respecting the distribution of the fixed stars. It is quite evident that according to the views usually accepted, the stars which appear in any part of the heavens must be regarded as situated at very different distances from the eye; the faintest nine or ten times farther from us, at the very least, than the brightest, and the different stars altogether too far apart to exert any influence on each other. Indeed, whatever theory we may hold respecting stellar distribution, regarded generally, we must be prepared to recognise in the stars seen towards any part of the sky, objects which lie at very different distances. And regarding these objects as severally in motion, we must be prepared to find in general the utmost diversity, not only as respects the direction of the apparent motions of the stars, but also as respects the magnitude of these motions. It is only when one has adopted the theory that the stars are grouped according to special laws of aggregation, that one would be led to anticipate that here and there, almost as by accident, so to speak, some indications of their grouping might be discoverable in the characteristics of the stellar proper motions. Although I had become firmly convinced that the stars are not distributed throughout space with any approach to that general uniformity insisted on by many astronomers, I had very little hope that a suggestion I threw out a year ago in the pages of the *Student*, that the stellar proper motions if examined carefully might afford evidence in favour of my views, would be confirmed in any very distinct manner if the method I had pointed out should ever be applied. I knew that a certain community of motion in the constellation Taurus had led Mädler to important, but as I judged incorrect conclusions as to the nature of the stellar motions; but I also knew that that community of motion was one which could only be appreciated by the few who had convinced themselves of what was to be *expected* if the stars were uniformly distributed. I had an impression at that time that Mädler had examined the stellar proper motions over the whole of the northern hemisphere, and that it was the exceptional community of proper motion in Taurus which had led him to form his well-known theory respecting a central sun. It was only when I was reminded that he had in fact examined the stellar proper motions in the neighbourhood of Taurus alone, having been led by independent considerations to regard that neighbourhood as that within which a central sun was to be looked for, that I was encouraged to map down all the recognised proper motions. To my surprise I found that in Gemini, Cancer, and Leo, a community of motion far more striking than that noticed by Mädler in Taurus was to be recognised; and further, that though in other directions, as I had expected, stellar motions belonging to different depths in space were intermixed, it was yet possible to trace out laws of association indicating the existence of drifting star-groups in these directions also.

I lay very little stress on the indications which have led me to name the great double cluster in Perseus as more likely to be an important centre of motion than the Pleiades. But it is worthy of mention that Mädler required a star on the Milky Way as the centre of the galaxy, and Alcyone does *not* lie on the Milky Way; he required his centre to lie ninety degrees from the apex of the solar motion, and Alcyone does *not* lie ninety degrees from the mean of the last determinations of that point. The great cluster in Perseus fulfils both conditions in the most perfect manner.

RICHARD A. PROCTOR

A careful examination of the proper motions of all the fixed stars in the catalogues published by Messrs. Main and Stone (Memoirs of the Royal Astronomical Society, vols. xxviii. and xxxiii.) has led Mr. Proctor to the conclusion that in parts of the heavens the stars exhibit a well-marked tendency to drift in a definite direction. "In the catalogues of proper motions, owing to the way in which the stars are arranged, this tendency is masked; but when the proper motions are indicated in maps, by affixing to each star a small arrow whose length and direction indicate the magnitude and direction of the star's proper motion, the star-drift (as the phenomenon may be termed) becomes very evident. It is worthy of notice that Mädler, having been led by certain considerations to examine the neighbourhood of the Pleiades for traces of a community of proper motion, founded on the drift he actually found in Taurus his well-known theory that Alcyone (the *tucida* of the Pleiades) is the common centre around which the sidereal system is moving. But in reality the community of motion in Taurus is only a single instance, and not the most striking that might be pointed out, of a characteristic which may be recognized in many regions of the heavens. In Gemini and Cancer there is a much more striking drift towards the south-east, the drift in Taurus being towards the south-west. In the constellation Leo there is also a well-marked drift, in this case towards Cancer.

"These particular instances of star-drift are not the less remarkable, that the stars are drifting almost exactly in the direction due to the proper motion which has been assigned to the sun, because the recent researches of the Astronomer Royal have abundantly proved that the apparent proper motions of the stars are not to be recognised as principally due to the sun's motion. Mr. Stone has shown even that we must assign to the stars a larger proper motion, on the average, than that which the sun possesses. Looking, therefore, on the stars as severally in motion, with velocities exceeding the sun's on the average, it cannot but be looked upon as highly significant that in any large region of the heavens there should be a community of motion such as I have described. We seem compelled to look upon the stars which exhibit such community of motion as forming a distinct system, the members of which are associated indeed with the galactic system, but are much more intimately related to each other. In other parts of the heavens, however, there are instances of a star-drift opposed to the direction due to the solar motion. A remarkable instance may be recognised among the seven bright stars of Ursa Major. Of these, the stars β, γ, δ, ϵ, and ζ are all drifting in the same direction, and almost exactly at the same rate towards the "apex of the solar motion," that is, the point *from* which all the motions due to the sun's translation in space should be directed. If these five stars, indeed, form a system (and I can see no other reasonable explanation of so singular a community of motion), the mind is lost in contemplating the immensity of the periods which the revolutions of the components of the system must occupy. Mädler had already assigned to the revolution of Alcor around Mizar (ζ Ursæ) a period of more than 7000 years. But if these stars, which appear so close to the naked eye, have a period of such length, what must be the cyclic periods of stars which cover a range of several degrees upon the heavens? In like manner the stars α, β, and γ Arietis appear to form a single system, though the motion of α is not absolutely coincident either in magnitude or direction with that of β and γ, which are moving on absolutely parallel lines with equal velocity. There are many other interesting cases of the same kind." The author hopes soon to be able to lay before the Royal Society a pair of maps in which all the well-recognised proper motions in both hemispheres are exhibited on the stereographic projection. In the same maps also the effects due to the solar motion are exhibited by means of great circles through the apex of the solar motion, and small circles or parallels having that apex for a pole. The star-drift described by Mr. Proctor serves to explain several phenomena which had hitherto been thought very perplexing. In the first place, it accounts for the small effect which the correction due to the solar motion has been found to have in diminishing the sums of the squares of the stellar proper motions. Again, it explains the fact that many double stars which have a common proper motion, appear to have no motion of revolution around each other; for clearly two members of a drifting system might appear to form a close double, and yet be in reality far apart and travelling, not around each other, but around the centre of gravity of the much larger system they form part of. While mapping the proper motions of the stars, Mr. Proctor has been led to notice that the rich cluster around χ Persei falls almost exactly on the intersection of the Milky Way with the great circle which may be termed the equator of the solar motion; that is, the great circle having the apex of the sun's motion as a pole. This circumstance points to that remarkable cluster, rather than to the Pleiades, as the centre of the sidereal system, if indeed that system has a centre cognisable by us. When we remember that for every fixed star in the Pleiades there are hundreds in the great cluster in Perseus, the latter will seem the worthier region to be he centre of motion. The author is disposed, however, to regard the cluster in Perseus as the centre of a portion of the sidereal system, rather than as the common centre of the Galaxy.

SOCIETIES AND ACADEMIES

Royal Society, February 24.—The President in the chair. The following papers were read: "Note on certain Lichens." By John Stenhouse. Usnic acid extracted from *Usnea barbata* by dilute solution of carbonate of soda was found to have the formula $C_{18}\,H_{18}\,O_7$, and the sodium salt $C_{18}\,H_{17}\,Na\,O_7$. This result accords with that of Hesse and differs from that of Knop, Rochleder, and Heldt, whose analysis give the formula $C_{19}\,H_{18}\,O_7$. Usnic acid was also obtained from *Evernia prunastri* as well as evernic acid. Tetrabrom-evernic was got by the action of bromine on evernic acid. Its formula is $C_{18}\,H_{12}\,Br_4\,O_7$. The acid extracted from *Cladonia rangiferina*, though possessing the same composition as usnic acid, was observed by Hesse to have a different melting-point (175° C.) from ordinary usnic acid (203° C.) He proposed, therefore, to call it β-usnic acid, as it so closely resembled ordinary usnic acid in its general character. The author has found that ordinary usnic acid, melting at 203° C., obtained from *Evernia prunastri*, *Ramalina calicaris*, and the various *Usneas*, does not yield a trace of β-orcin when distilled, whilst, on the contrary, the acid extracted from *Cladonia*, on being subjected to the same treatment, yields β-orcin; thus showing a marked difference in the products of its decomposition from ordinary usnic acid, as well as in its melting-point. Under these circumstances, therefore, he proposes to name the acid from *Cladonia rangiferina* "Cladonic Acid," instead of β-usnic acid, as proposed by Hesse. He intends to continue the study of this acid.

"On the successive action of Sodium and Iodide of Ethyl upon Acetic Ether." By Prof. Frankland and Mr. B. F. Duppa. The authors, referring to a paper by Mr. Wanklyn, wherein it is stated that their interpretation of the nature of the reaction between sodium and acetic acid must be erroneous because it involves the disengagement of hydrogen, remarked that Mr. Wanklyn's opinion is founded upon experiments which differ essentially from their own, and not warranting the conclusion which he has drawn from them. The authors allowed all evolved gas freely to escape, while Mr. Wanklyn operated in sealed tubes under great pressure. M. L. Cailletet has recently shown that the evolution of hydrogen from zinc and hydrochloric acid is gradually diminished and finally stopped under increasing pressure, while the evolution of hydrogen from sodium-amalgam and water is diminished and finally stopped in a sealed tube. Since pressure retards or even interrupts a reaction in which a permanent gas is evolved, whilst it is known to exercise little or no influence upon other chemical changes in which no evolution of gas takes place, the authors consider this influence of pressure affords an explanation of the difference between the results of Mr. Wanklyn's experiments and their own, as regards the evolution of hydrogen during the action of sodium upon acetic ether. They confirm his observation that sodium dissolves in valeric ether, under ordinary atmospheric pressure, without the evolution of any gas; adding that since a reaction, whatever its nature may be, which thus proceeds readily with ethylic valerate, can scarcely be impossible with its homologue, acetic ether, it is probable this reaction goes on side by side with those which they have described, but that when the pressure is moderate those changes chiefly take place which involve the disengagement of hydrogen, whilst under the great pressure arising in sealed tubes, those changes being more or less suppressed, the reaction observed by Mr. Wanklyn comes into prominence. The authors reserve their observations upon Mr. Wanklyn's views regarding the changes which take place when sodium acts upon acetic, butyric, and valeric ethers, until the publication of the experimental data upon which those views are founded.

Ethnological Society, February 22.—Prof. Huxley, president, in the chair. Mr. E. Backhouse was announced as a new member.—By the courtesy of Dr. Lockhart, a calva from China was exhibited by Prof. Busk, in illustration of a former paper on an ancient calvaria which had been assigned to Confucius. The skull is mounted in copper, and was formerly supported on a tripod and furnished with a lid.—"On discoveries of archæological interest in recent deposits in Yorkshire." By Mr. C. Monkman, of Malton. The author described the discovery of worked flints in the clay of Kelsea Hill, in the East Riding of Yorkshire. This was formerly regarded as belonging to the Hessle clay—a post-glacial deposit unconformable to the true boulder clay of Holderness—but it is probably only a derivative clay washed from the Hessle deposits on Kelsea Hill. It may, therefore, be of comparatively recent origin. Large finds of implements of Neolithic type are reported to have been made in the York sands. Many stone implements have also been found in the old river deposits in the Vale of Pickering, chiefly turned up in the prosecution of land-drainage works. The paper was illustrated by a fine collection of specimens.—"On the Natives of Naga, in Luzon, Philippine Islands." By Dr. Jagor. The author described in detail the manners and customs of the Bicol Indians who inhabit this locality. Dr. Campbell inquired whether there was any connection between the name of this place and the Sanskrit *naga*, a snake.

Entomological Society, February 21.—Mr. Alfred R. Wallace, president, in the chair. Professor Schiödte and Siebold were elected honorary members. Messrs. B. J. Lucas and G. T. Porritt were elected annual subscribers.—Mr. J. Hunter exhibited a moth captured in the New Forest, and supposed to be *Plusia ni*.—Mr. Albert Müller exhibited galls formed in the florets of the tansy by *Dipterous* larvæ.—Mr. Pascoe exhibited a beetle from King's George's Sound, the *Nepharis alata* of Castelman—*Hicketes thoracicus* of King, which latter name sinks.—Mr. A. G. Butler read a paper "On butterflies recently received by Mr. Swanzy from West Africa." Three new species were described of the genera, *Romaleosoma*, *Philognoma*, and *Mycalesis*.

London Mathematical Society, February 10. — Prof. Cayley, president, in the chair. Mr. A. Ramsay was elected a member. The president gave an account (second communication) of his paper on "Quartic Surfaces."—Mr. Walker made some further remarks on the subject of his paper on the "Equations of Centres and Foci, and conditions of certain Involutions," read at the January meeting of the society.—The condition that a quadric (v) should determine a pair of corresponding points in one of the three involutions given by a quartic (u) is the vanishing of the cubic invariant of $12\,uv$. When u and v are the Jacobian and quadric covariants of two cubics the preceding condition expresses that the two cubics determine an involution. When one of the two cubics (v) is the cubic covariant of the other (u) the two determine four distinct involutions; and the Hessian of u determines the foci in one of the four—viz., that in which the points harmonically correspondent are also correspondent in the involution. The other three involutions are not analytically distinguishable one from another.—Mr. Clifford read a paper "On a case of Evaporation in the order of a Resultant." In it he established the two following theorems:—"Let it be required to eliminate x between two equations homogeneous in x, and certain other variables $y, z, \ldots$ in which equations, however, x only occurs in virtue of the occurrence of a quantity $w = x^\alpha y^\beta z^\gamma, \ldots$ where $\alpha+\beta+\gamma+\ldots = \mu$; let, also, m, n be the orders of the equations, and h, k the remainders after division of m and n respectively by μ; then the order of the resultant is

$$= \frac{m\,n - hk}{\mu}.$$

Theorem 2. "Let it be required to eliminate $\kappa - 1$ variables $x, y, \ldots$ from k equations homogeneous in these and certain other variables, in which equations, however, x, y, only occur in virtue of the occurrence of $k-1$ quantities $u, v, \ldots$ all of the same order μ; let also $m_1, m_2, \ldots m_\kappa$ be the orders of the equations, and $m_i = p_i\mu + h_i$, $h_i < \mu$; then the order of the resultant is

$$\Pi p\,(\Sigma\,\frac{h}{p} + \mu).$$"

Mr. Perigal presented to the Society a copy of his "Geometric Maps and Contributions to Kinematics."

Meteorological Society, January 19.—Charles V. Walker, president, in the chair. The Rev. J. Crompton, Dr. C. Fox, and Mr. E. J. Sykes were elected Fellows. The following papers were read: "On the Temperature and Humidity of the Air at the Heights of 22 feet and 50 feet above the ground, in comparison with the Temperature and Humidity of the Air at the Height of 4 feet." By Mr. Glaisher. Our knowledge of the temperature and humidity of the air near the surface of the earth is almost entirely confined to within 4 or five feet above the earth. The theory that the temperature was always lower at higher elevations was proved not to be at all times true, and the theory of the decline of 1° of temperature in every increase of 300 feet of elevation, was proved to be erroneous. The author stated the results of his observations in the great Captive Balloon, at Ashburnham Park, Chelsea, which M. Giffard

kindly placed at his disposal for the purpose. This balloon could ascend to the height of 200 feet on a calm day; its rate of ascension could be regulated at will; it could be kept stationary at any elevation, and experiments could be repeated several times in the day. From these results the author considered it to be evident that observations, even up to 50 feet, give more information than could be obtained by the use of either a free or captive balloon, as to the temperature and humidity of the air at moderate elevations. If carried through an entire year, this would give the seasonal as well as diurnal changes; such experiments are in progress at present, and several months' observations have already been made, the results of which will be placed before the Society at a future time.—"Rainfall at Jerusalem during the Rainy Season of 1868-69." Dr. T. Chaplin.

MANCHESTER

Literary and Philosophical Society, February 8.—Mr. J. P. Joule, president, in the chair. Mr. Binney, referring to his previous notice of stray boulders without traces of clay, high up the western slopes of the Pennine chain, about 1,000 feet above the level of the sea, said that Mr. A. H. Green and his colleagues had stated, in their valuable memoir on the carboniferous limestone, yoredale rocks, and millstone grit of North Derbyshire and adjoining parts of Yorkshire, just published by the Geological Survey, that they believed the eastern plain from Sheffield through Chesterfield down to Belper, to be in the main free from drift. Mr. Binney had often searched for boulders in the neighbourhood of Chesterfield. The only foreign rock which he met with in that district was a large block of greenstone several hundred pounds in weight, above the valley of the Hipper near Spring Bank and below the waterworks station, Chesterfield. The stone was well rounded and polished. He mentioned the fact to direct the attention of observers to this subject on both the eastern and western slopes of the Pennine chain. Probably they have only to be more diligently sought for in order to be found in greater abundance.

"On Convertent Functions." By Sir James Cockle. This was a supplement to the author's paper "On convertent functions." The convertent equation (3) contains in substance only one disposable arbitrary, and the sign of summation Σ does not increase, and may be expunged from it without diminishing, its generality. Consequently the process would fail to convert the Boolian integral for the cubic and lead only to illusory results. But a recognition of this failure had led him to another form of convertent equation. And first, if to the several dexters of (2) and (3) we add a term h, then the conversion will be possible, even though h be not a perfect differential co-efficient, provided only that $\int hdu$ be assignable within the limits of the integration.

Mr. Spence repeated the experiment he had made at the Exeter meeting of the British Association, showing that the temperature of saturated saline solutions could be raised to their boiling points by merely passing them through ordinary steam at a temperature of 212°. Thus, a solution of chloride of sodium was raised to a temperature of 221°, and one of chloride of calcium to 248°.

"On the Natural Ropes used in packing Cotton Bales in the Brazils." By Mr. Charles Bailey. Most of the cotton bales which reach this country from the Brazils are corded with the long stems of climbing plants growing in profusion in the forests bordering on the cotton districts. In their fresh state these stems are exceedingly pliant and of remarkable strength, so that they serve admirably for cordage purposes, but by the time that the cotton reaches the mills of Lancashire they become dry and rigid, and as no further use can be made of them, they are burned for firewood. Being very long, they are very troublesome to put on the boiler fires, and most millowners are glad to get rid of them. These objects are invested with singular interest when examined in regard to their structure, for although the external form of many of them is extremely curious, their chief interest centres in their remarkable internal organisation. Although they reach this country in immense quantities, they are not often to be met with in our museums or colleges, and the names of the plants which produce them are for the most part unknown. The *Bignoniaceæ* stands pre-eminent as the natural order most largely used for supplying lianas for packing purposes, both as regards the quantity of ropes, and the largest number of species. *Malpighiaceæ*, *Sapindaceæ*, *Leguminosæ*, *Aristolochiaceæ*, and *Ampelideæ* also yield these ropes. There are many other species found amongst these ropes which belong to other natural orders, such as the *Menispermaceæ*, *Gnetaceæ*, *Asclepiadaceæ*, &c., but our knowledge of them is too limited to assign them to their respective orders. Most of the author's specimens have come from bales of Santos cotton. The whole of these lianas furnish beautiful objects for the microscope.—Mr. Forrest suggested that useful dyes might be obtained from the plants described by Mr. Bailey.—In reply to a question from the Rev. Brooke Herford, Mr. Bailey stated that owing to a difference in the structure and general appearance of some of the stems in his possession, he had been led to suspect that they were aërial roots of some of the plants he had exhibited and described.

CAMBRIDGE

Philosophical Society, February 21.—The following papers were read:—"The antiquity of some of our familiar agricultural terms." By Mr. Paley (St. John's). After some general remarks upon the English language, and the fact that agricultural life was peculiarly favourable to the preservation of old words, Mr. Paley called attention to the fact that while in our language the generic names of animals are usually of Saxon origin, the words denoting their application are usually of classic origin. Words which are not generic, but particular and descriptive, are also generally of classic origin. He then proceeded to discuss the derivation of a large number of familiar agricultural terms in illustration of the above remarks.—"Proof that every rational equation has a root," and "The space theory of matter," both by Mr. Clifford (Trinity.)

GLASGOW

Natural History Society of Glasgow, January 25.—Prof. John Young, president, in the chair. "On the claims of Natural History as a branch of education" By J. W. Allan. The author advocated the teaching of zoology and other branches of natural history in schools, also that zoology should occupy a more important place in the curriculum in all universities. At its close Prof. Young made some remarks bearing on the different aspects of the question.—"On the introduction of the wild turkey (*Meleagris Gallopavo*) into Argyleshire." By John Gilmour. The author of this paper mentioned having received three specimens of this beautiful bird—a male and two females—from the southern extremity of Lake Huron, in Canada, in the summer of 1866, since which time various broods had been successfully reared in the neighbourhood of Ardlamont, where the birds had been allowed their full liberty in the woods. Mr. Gilmour concluded his paper with a description of the wild bird as compared with domestic breeds, remarking that it possessed greater symmetry with a more compact form, standing higher on its legs, and exhibiting other characters more like those of a game bird than one of the gallinaceous order. Mr. Gray mentioned that there are now supposed to be three different species of *Meleagris* besides the *M. ocellata* of Honduras and other parts of Central America, namely, *M. Americanus*, which is probably peculiar to the eastern half of North America; *M. Mexicana* of Gould, a species belonging to Mexico and extending along the table lands to the Rocky Mountains, the Gila and the Llano Estacado; also the *M. Gallopavo* of Linnæus, or domesticated bird. This last species was perhaps originally indigenous to one or more of the West India Islands, whence it was taken in a tamed state to various parts of North America, and thence to Europe about the year 1520. The domesticated bird differs from the nearly allied wild species in having a largely-developed dewlap extending from the base of the under mandible down the fore part of the neck to its base, and it cannot yet be said to be a settled question as to the precise original stock from which the valuable barn-yard breeds have descended.—"Notes on the genera of extinct fossil shells—*bellerophon* and *porcellia*; their classification amongst the mollusca, and their distribution in the silurian and carboniferous strata of the west of Scotland." By John Young. Mr. Young stated that at one time this interesting group of shells had been placed by palæontologists among the cephalopods, the highest division of the mollusca, and regarded as fossil representatives of the recent *argonautidæ*, which possess a symmetrically coiled shell as in *bellerophon* and *porcellia*, but, like them, not chambered as in the genus *nautilus*. In the more recent classification of the mollusca, *bellerophons* and *porcellia* are now placed amongst the gasteropods, and in that division termed the *neucleobranchiata*, which consist of entirely pelagic animals, some having shells, others none, and, according to Woodward, swimming at the surface instead of creeping on the bed of the sea. Prof. Owen believes, however, that it can scarcely be insisted all were necessarily floaters on account of their organisation. In recent seas the extinct genera are represented by the

genus *Atlanta* and the sub-genus *oxygyrus*. In palæozoic times the genus *bellerophon* commenced its existence, so far as is known, in the lower Silurian, and became extinct in the carboniferous period.

NEWCASTLE-UPON-TYNE

Chemical Society, November 25, 1869.—I. Lowthian Bell, president, in the chair. "On the estimation of Peroxide of Manganese in Manganese Ores," by E. Sherer and G. Rumpf. The authors showed that the method of Fresenius and Will is open to the objection of giving results which do not always agree with those obtained in the practical use of manganese for producing chlorine. They recommended Bunsen's method of testing as better adapted for the valuation of manganese ore.

BRIGHTON

Brighton and Sussex Natural History Society, February 10. The president, Mr. T. H. Hennah, in the chair. The hon. sec., Mr. T. W. Wonfor, exhibited a collection of *galls*, found on British plants, made by Mr. W. H. Kidd, and read a description of each one of the insects producing them, drawn up by the same gentleman. The collection is intended for the Brighton Museum. Mr. Wonfor then read a paper on Seeds. Commencing with the first appearance of the ovule in the unexpanded flower-bud, as a pimple consisting of an aggregation of cells, its gradual development and the impregnation by the pollen, together with its coeval parts, were traced until the perfect seed, ready for dissemination and containing within it the embryo of the future plant, was fully formed. The various modes by which the seed is scattered, the numbers produced by some plants, the power possessed by some of resisting heat and cold, and the wonderful property possessed by others of preserving their vitality, under apparently very adverse circumstances, for long periods of years, were each discussed. On the subject of artificial selection, it was shown what has been done, notably by Mr. F. Hallett, of Brighton, with cereals in increasing both the size and number of grains in an ear; something similar might be done with other plants. Seeds, as objects for the microscope, were next discussed. From a long series of examinations of wild and cultivated seeds, spread over several years, while unwilling to lay down any law of classification by their microscopic appearance, yet often in the case of unknown seeds he had been able to determine the family to which they belonged from certain peculiarities common to many plants of the same family. Seeing how varied and beautiful they were, and how little preparation they required, he considered they were not attended to by microscopists so much as they deserved. The paper was illustrated by a large collection of seeds and microscopic preparations.

VIENNA

Imperial Academy of Sciences, January 7. — Memoirs were communicated "On some constituents of the fruit of *Cerasus acida*, Borkh.," by Professor H. Rochleder, and on a spiral valve in the portal vein of the Rodentia, by Professor J. Hyrtl. —Herr von Haidinger presented a note by Dr. S. Meunier on the victorite or enstatite of the meteoric iron of Deesa, in Chili, which was said to be perfectly colourless and transparent and to contain no trace of iron. He also made some remarks on the study of meteorites, regarding them as the last step in the development of our planetary system.—Professor F. Unger communicated a memoir on the occurrence of Typhaceous plants (*Typha* and *Sparganium*) in tertiary deposits.—Prof. E. Mach presented a preliminary communication on an apparatus constructed by him for the observation of sound-movements.—Dr. Samuel Kónya communicated an account of his investigation of the mineral water of Wielutza, near Jassy, in Roumania. He obtained about 0·9 per cent. of solid constituents, of which 0·574 was sulphate of soda, and nearly 0·18 sulphate of magnesia. The water also contained chloride and carbonate of magnesia.— A memoir by MM. J. Rumpf and F. Ullik, on the Ullmannite of Waldenstein in Carinthia, was presented by Professor Peters. —Professor Graber communicated an account of the Orthoptera of level districts among the Austrian Alps.

January 13.—A report was communicated from Dr. von Scherzer upon the proceedings of the scientific members of the East Asiatic Expedition. The following specimens were specially noticed:— Three Chinese and three Japanese skulls, a collection of freshwater fishes from Osaka in Japan, and a number of Chinese drugs.—A memoir "On nexus of curves," by Dr. Emil Weyr, was presented.—M. Haidinger communicated the contents of a series of letters from Professor W. H. Miller, relating to meteorites.—M. A. Waszmuth forwarded a memoir on a new method of determining the reduction-factor of a tangent compass. —Herr J. Effenberger announced that he had succeeded, upon scientific principles, in producing violins which in power of tone approached those of the old makers.—Professor Reuss presented a memoir on Upper Oligocene corals from Hungary, in which he described 16 species of corals from the beds in the neighbourhood of Gran, which contain abundance of *Nummulites Lucasana* and *perforata*, and were formerly regarded as of Eocene age : half the species are new; of the other half, seven have occurred in the beds of Castel-Gomberto and Oberburg.—A memoir by Dr. Leo Levschin, containing a description of the structure and vessels of the intestine of *Salamandra maculata*, was presented by Professor Langer.—Herr. F. Unferdinger communicated a memoir on the transformation and determination of a certain triple integral.—M. H. Obersteiner read a paper on some lymphatic spaces in the brain : and Dr. S. L. Schenk presented a memoir on the amount of nitrogen in the flesh of various mammals, in which he stated that this quantity is variable, ranging from 3·06 to 4·21 per cent.

PARIS

Academy of Sciences, February 21.—At this meeting M. Becquerel communicated a memoir on the production of electro-capillary currents in the bones, nerves, and brain.—M. de Saint Venant presented a report on a memoir by M. Boussinesq, relating to the theory of periodical liquid waves, and another on a supplement by M. Tresca to his memoir read on the 27th of November, 1864, on the flowing of solid malleable bodies pressed out of a cylindrical vase through a circular orifice.— The astronomical and physical communications were :—A notice of a direct and easy method of effecting the development of the perturbative function and of its differential coefficients, by Mr. S. Newcomb; and a note by M. A. Martin on the method adopted by Léon Foucault, to ascertain whether the surface of a mirror is strictly parabolic.—The following papers were read on chemical subjects :—A note on synthesis of aromatic acids, by M. A. Wurtz, in which the author described a series of acids produced by the action of amalgam of sodium upon mixtures of brominated toluene and chloride of benzyle, with chloroxycarbonic ether.—A paper containing facts relating to the stability as chemical species of normal propylic, butylic, and amylic alcohols, by MM. J. Pierre and E. Puchot. The authors described a series of observations made upon these substances under various conditions, from which they concluded that the three alcohols were specifically different. They remarked that amylic alcohol is the only one of the three which exerts any sensible action upon polarised light.—A memoir on the artificial digestion of feculent bodies by maltine, by M. L. Coutaret, in which he stated that the action of maltine or vegetable diastase upon cooked starchy matters is precisely analogous to that of the salivary diastase, and recommended the use of the former in cases of dyspepsia.—A note by M. A. Lamy on a new kind of thermometer, founded on the principle of "dissociation," that is to say, on the determination of the amount of gas given off by a solid body at different temperatures. The substance employed by the author is a double chloride of calcium and ammonia. The author regarded his method as particularly applicable to the determination of temperatures low down in the earth or in deep soundings. M. Becquerel remarked that for temperature-observations at various depths in the earth, he had several years ago proposed a method which gave good results.—A note by M. Reboul on combinations of the hydro-acids with brominated ethylene and propylene. — A note by M. A. Colley on the action of the free haloids and of some chlorides upon glucose, in which he described a new compound obtained by the action of chloride of acetyle upon glucose, which he proposes to name *acetochlorhydrose* ($C^6H^7(C^2H^3O)^4Cl$).—A notice of a new phosphuretted compound by MM. Darmstädter and Henninger. This body, which the authors named *cyanethylphosphide*, was obtained by the action of an etherial solution of phosphuretted hydrogen upon chloride of cyanogen. And, lastly, a chemical and therapeutical investigation of the thermal water of the solfatara of Puzzoli, by M. S. De Luca; the water contains free sulphuric acid. The only purely mathematical communication was a memoir by M. Halphen on algebraical left curves.—General Morin presented a memoir by M. Goldenberg describing improvements introduced by him in the ventilation of the grinding and polishing works at Zorrhoff, near Saverne.—M. H. Sainte-Claire Deville communicated some further remarks by M. A. Schafarik,

on the diamonds discovered at Dlaschkowitz in Bohemia, in which it was stated that fragments of the stone have been burnt, for the purpose of demonstrating its identity with diamonds from other localities.—A note from M. Liebreich on the use of strychnine as an antidote for chloral, was presented by M. Wurtz. The physiological action of these two substances was stated to be so antagonistic, that either of them may be employed with more or less effect as an antidote to the other.—M. Duchartre communicated a memoir by M. Prillieux on the formation of small masses of ice in the interior of plants. These masses, which occur in many plants, when exposed to severe frosts, were described by the author as composed of numerous prismatic needles closely applied to each other, and formed in lacunæ between the cells of the living tissues.—M. A. Chatin presented a second note on the causes of the dehiscence of anthers, in which he described the part taken in the production of this phenomenon by the second membrane or mesothecium.—M. F. Lenormant continued his notes on animals known to the ancient Egyptians, with an account of the domestication of some species of antelopes under the old empire, especially the fourth and fifth dynasties—Of the following communications no particulars are given. A memoir by M. Delaurier on a new general theory of the production of static and dynamic electricity,—an *electro-thermic theory;* a memoir on the pathology and therapeutics of cholera, by M. J. de Zycki of Wilna; a note by M. G. Adeline on the influence of copper as a preservative from cholera; a note by M. Allegret in continuation of his remarks on the geometrical representation of the elliptical function of the first kind with an arbitrary modulus, &c.; a note on the theory of magic squares, by M. Marie; a letter on the formation of ice, and a note on a case of catalepsy from Mr. Jackson Davis.

New Zealand

Wellington Philosophical Society, November 13, 1869.—Mr. W. L. Travers, F.L.S., in the chair.

Dr. Hector called attention to two live specimens of the mud fish from Hokitika, *Neochanna apoda* of Gunther. The specimens were swimming actively in clear water, and had perfect vision, although their eyes are small, so that the undeveloped state of the eye in the specimen previously received must have been exceptional. The Hon. Mr. Fox remarked that these mud fish were not peculiar to Hokitika. Five years ago he remembered seeing a fish dug up from a gravelly-clay ten feet below the surface at Rangitikei, and he believed that it was identical with the fish exhibited.

A remarkable meteor, observed in Wellington on the 8th inst. at 11.30 P.M., was described by the Rev. Mr. Stock. It was observed in E.S.E. and descended almost vertically with three distinct coruscations, attended by showers of sparks and bright prismatic colours. The brightness was equal to that of Venus. Mr. Kebbell and Mr. Gillon corroborated Mr. Stock's observations. A description of three additions to the New Zealand flora, with specimens, was laid on the table, and Dr. Hector gave a short abstract of a report by Mr. Kirk, of Auckland, on the botany of Cape Colville peninsular. This paper gave the results of a survey that had been made for the Geological Department for the purpose of obtaining an accurate record of the original vegetation, as it was undergoing rapid modification by the gold diggers. Several new species of plants were described, of which specimens were exhibited.

The next paper was a description of the mechanical apparatus employed in raising the *Turanaki*, by Mr. J. T. Stewart. Dr. Hector directed attention to a collection of the marine animals that were found on the vessel, among which are three species of *anomia*, two of *mytilus*, *ostrea*, *pecten*, *serpula*, *balanus*, and *teredo*. He remarked that some of these animals are usually confined to depths only slightly below low water. Their occurring so well-grown within a year at the depth of 100 feet, seemed to indicate that depth of water did not so much control their existence as a supply of nourishment, which was probably abundant near the wreck.

Mr. Skey showed that the temperature obtained by the common blowpipe, with proper precautions against conduction of heat, was at least 5,100° Fahr., as it is capable of fusing fine points of platinum, and described a new process to facilitate the analysis of supposed auriferous quartz, when sulphides were present in large quantities. Iodine or bromine is used as the solvent, and a rapid test is obtained by dipping filter paper in the solution and burning it with due care, when if gold be present a very characteristic purple hue is imparted to the ash. By this test the presence of gold in the proportion of one dwt. in the ton can be detected with great economy and certainty.

Dr. Hector described the bones of a fossil penguin recently discovered on the west coast of Nelson, and presented to the museum by Mr. Dingan. The discovery is interesting, as a fossil bone found by Mr. Mantell in the Oamaru limestone of Otago in 1849, was pronounced by Prof. Huxley to belong to a gigantic penguin five feet in height. The fossil bones found by Mr. Dingan, appeared to be those of a bird not larger than penguins that still exist in antarctic seas. The fossil shells sent from the same formation as the bones, indicate that they belong to a lower pliocene period.

Mr. Hamilton read a paper on the educational system.

DIARY

THURSDAY, March 3.

Royal Society, at 8.30.—Results of Monthly Observations of Dip and Horizontal Force made at Kew Observatory: Dr. Balfour Stewart.—Spectroscopic Observations made with the great Melbourne Telescope, Nebula in Argo, and the Spectrum of Jupiter: A. Le Sueur.
Chemical Society, at 8.—Indices of Refraction: Dr. Gladstone.
Linnean Society, at 8.—Hybridism among Cinchonæ; Mr. J. Broughton.
Pathological Society, at 8.
Royal Institution, at 3.—Chemistry of Vegetable Products: Prof. Odling.
Society of Antiquaries, at 8.30.—Monastic Inventories: Rev. M. S. C. Walcott.
London Institution, at 7.30.

FRIDAY, March 4.

Geologists' Association, at 8.
Philological Society, at 8.15.
Royal Institution, at 9.—Iron-built Ships: Mr. E. J. Reed, C.B.
Archæological Institute.

SATURDAY, March 5.

Royal Institution, at 3.—Science of Religion: Prof. Max Müller.

MONDAY, March 7.

London Institution, at 4.
Medical Society, at 8.
Entomological Society, at 7.
Society of Arts, at 8.—Cantor Lecture: Dr. Paul.
Royal Institution, at 2.—General Monthly Meeting.

TUESDAY, March 8.

Photographic Society, at 8.
Ethnological Society, at 8.—On the opening of a Cairn in North Wales: Col. A. Lane Fox.—On the Earliest Phases of Civilisation: Hodden M. Westropp.
Institution of Civil Engineers, at 8.—The San Paulo Railway, Brazil: Mr. D. M. Fox, M. Inst. C.E.
Medical and Chirurgical Society, at 8.30.
Royal Institution, at 3.—Plant Life: Dr. Masters.

WEDNESDAY, March 9.

Society of Arts, at 8.—Street Tramways: W. B. Adams.
Archæological Association, at 8.
Royal Microscopic Society, at 8.—1. On the Comparative Steadiness of the Ross and Lister Models under Trying Circumstances; 2. On the Shell Structure of Fusulina; 3. On the Microphyle of the Fish's Ovum; 4. On the Reparation of the Spines of Echini: Dr. W. B. Carpenter.
Geological Society, at 8.—On the Structure of a Fern-stem from the Lower Eocene of Herne Bay, and on its allies, recent and fossil: Mr. W. Carruthers, F.L.S., F.G.S.—On the Oolites of Northamptonshire: Mr. Samuel Sharp, F.G.S.—On the Geology of the district of Waipara River, New Zealand: Mr. T. H. C. Hood, F.G.S.

THURSDAY, March 10.

Royal Institution, at 3.—Chemistry: Prof. Odling.
Royal Society, at 8.30.
Mathematical Society, at 8.
Zoological Society, at 8.30.—On Dinornis: Professor Owen.—Description of a new species of *Ampullaria*: Dr. J. C. Cox.—On the Birds of Veragua: Mr. O. Salvin.—On new birds from the Yantze-kiang: Mr. R. Swinhoe.
London Institution, at 7.30.

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