

THURSDAY, MARCH 23, 1871

## BOTANICAL MUSEUMS

THE keeping up at the public expense of two great rival National Botanical Establishments, the one in London the other at Kew, in a state of continual competition with, instead of aid to, each other, whilst a third independent one, also national, may occasionally come into collision with one of them, seems to be a waste of public money, without any advantage to science or to the public, and attended with many inconveniences.

At the same time two great Botanical Museums and Herbaria, the one in connection with the Natural History Museum in London, the other with the Botanical Gardens at Kew, working in harmony with each other, but for different purposes, and separated by a clear line of demarcation from the Economic Museums of South Kensington, would always be productive of great benefit to science and gratification to the public.

The main purposes of a Botanical Museum and Herbarium may be said to be threefold—the Study of plants, their Comparison, and their Exhibition; the first purely scientific; the second sometimes scientific, sometimes popular, the third chiefly popular. For the first, Kew affords incomparable advantages, the second and third would probably be best promoted in town, provided always that the two establishments work in perfect harmony, with unity of plan, both in general arrangements and in matters of detail.

1. For the close Study of plants,—the only sound foundation upon which the science of Botany can be usefully established,—for their accurate determination and practical classification, the requisites are: that the herbarium should be as rich as possible not only as to genera and species, but as to variations of all sorts and repetitions of the same form from different localities and stations; that the herbarium should be a single one, the geographical arrangement being kept in subservience to the scientific classification, and without any detached smaller herbaria, except such definite historical ones as only require occasional reference like the books of a library; that there should be good accommodation for the sorting of unnamed collections and fresh arrivals, ample means for the dissection and examination of specimens not only by the staff of the establishment, but also by scientific botanists in general, who, under special regulations, are allowed to work in the herbarium, and store-rooms for duplicates required for exchanges, &c.; that there should be in the same suite of rooms as the herbarium a botanical library, as complete as possible, and a series of drawings of plants, also as complete as possible; that the herbarium should be in close connection with the national collection of living plants; and that it should be under the keepership of a resident scientific botanist, with the requisite staff of scientific assistants. All these essentials are at present afforded by the Herbarium at Kew, in a degree far beyond what can be met with in any other establishment at home or abroad.

2. The Comparison of plants—their practical and rapid determination without dissection, or the obtaining a general idea of natural groups from the Order down to

the Species, as required by the general naturalist, by the follower of sciences in immediate connection with botany, especially the palæontologist, or by the mere amateur—demands a very different herbarium and museum from that of the working establishment. It should consist of accurately named select specimens, representative of as many species or well-marked varieties as possible, without duplicates in the same collection. It might be advantageously divided into two separate collections, one a general typical one, the other geographical. Separate collections also of leaves and of fruits, all accurately named, and so arranged as to enable them to be rapidly glanced over, would be most useful to the palæontologist. Such a museum would require no space for the sorting and determining of unnamed collections, nor for the storing of duplicates, and no provision for the dissection of specimens except for the personal use of the keeper and his assistants, being supplied only with such tables or other appliances for consultation as are usually required in a library. Its library should be extensive, but select rather than complete, and should include various palæontological and other works on kindred sciences, not required in the working herbarium. It should be in near connection with the National Museums for kindred sciences, especially with other palæontological collections. The keeper should be a scientific geologist, as well as botanist, and would require probably but one scientific assistant.

3. The Exhibition of plants, or rather of botanical specimens, is for the purpose of exciting the interest and gratifying the curiosity of the general public, and for this a herbarium, strictly so-called, is of no use—the public would never look beyond the outside of the cases. It requires the display in glass cases of such selected specimens of plants or their parts, accompanied by explanatory notes and diagrams, as may give at a cursory glance some idea of the characteristic features of the principal groups of plants; and to these might be usefully added a few specimens remarkable only for their beauty or singularity, for the purpose of attracting the eye, and riveting the attention of the observers. As these specimens, when once placed, require no further handling, and no care beyond the inspection of an ordinary assistant, and as the objects of visitors to such a Museum would be much promoted by a ready connection with the public Museums in other branches of natural history, it would seem highly advantageous that it should be attached to the herbarium for comparison, and form part of the London Botanical Museum, in close proximity to the National Museums of Zoology and Geology.

We have now no Museum in any degree adequate to these two purposes of Comparison and Exhibition, but were the two national collections of the British Museum and Kew combined, all unnamed plants, duplicates, and specimens of interest only to the scientific botanist, removed to Kew, and in return, from the immense mass of materials there accumulated, the London herbaria completed by accurately-named representative specimens, there would result collections richer in species and far more useful than any actual Continental ones; and as science advances and materials increase, these collections would be constantly kept up to the mark by named specimens from Kew, whilst their scientific arrangement and application to use could not be under a direction better

qualified than that of the recently-appointed keeper of the botanical department of the British Museum.

In this London Botanical Museum would be also appropriately placed various pre-Linnean and other botanical collections, having only a historical or other adventitious interest, but there would be little use in attempting there anything corresponding with the Museum of Economic Botany, which has acquired so much importance, and is so well placed at Kew. That could only come into competition with the economic collections at South Kensington, but all prejudicial collision between the two is clearly avoided, and each one will increase its own practical utility by strictly adhering to the rule that at Kew the products are arranged according to the plants they are derived from; at South Kensington, according to the uses they are put to.

#### POPULAR ORNITHOLOGY

*Cassell's Book of Birds.* Translated and adapted from the text of the eminent German Naturalist, Dr. Brehm, by Thomas Rymer Jones, F.R.S., Professor of Natural History and Comparative Anatomy in King's College, London. 400 woodcuts and coloured plates. Parts I.—XIV. (London: Cassell, Petter, and Galpin.)

PERSONS wishing to be misinformed on the subject of Ornithology should obtain and read the "Book of Birds" now in course of publication by Messrs. Cassell, Petter, and Galpin, and recommended by them to "everyone who wishes to know all that is known about birds." The advertisement whence these words are quoted also tells us that the work, when completed, is to contain "upwards of 400 engravings, embracing every species of birds known to exist;" but as on a moderate computation some 12,000 species of birds have been described, it is pretty clear that to fulfil that promise each engraving should represent 30 species or thereabouts. The most cursory inspection of the portion published (and we have the fourteenth part lying before us) will show that nothing of the kind has been done, and that many groups are left without an illustration at all.

Furthermore, the work is announced as "translated and adapted from the text of the eminent German naturalist, Dr. Brehm, by Thomas Rymer Jones, F.R.S., Professor of Natural History and Comparative Anatomy in King's College, London," a collection of assertions which we take the liberty of questioning. We are aware of the recent existence of no fewer than four German naturalists of that name, all of them, we believe, entitled to the doctoral prefix. Of these four, which is the one whose labours are chosen for the exercise of Prof. Jones's industry in translation and ingenuity in adaptation? *The eminent* Dr. Brehm ought, of course, to be the answer; but then the most "eminent"—that is the best known and most prolific writer of the four—was Dr. Christian Ludwig Brehm, who, having attained great notoriety as a "splitter" of species, died at an advanced age some half-dozen years since, leaving two of his three bedoctored sons behind him. Now, Dr. Brehm, the father, among his many works certainly never published one which could be "adapted" to the form of Messrs. Cassell's "Book of Birds:" nor did Oscar Brehm, the son, who died in his father's lifetime. The question is therefore narrowed to

the works of the survivors. Of these Dr. Reinhold Brehm has contributed several ornithological papers to journals, but none of any great importance, and there is no need to accredit him with the authorship of any work at all resembling the present. It seems therefore that Dr. Alfred Brehm must be in the eyes of the English publishers and translator "the eminent Dr. Brehm." We are inclined to believe that the production we are now reviewing is his offspring, whether he deserves to be called "the eminent German naturalist" or not, and that it has not hitherto been printed, since an examination of his work, "Das Leben der Vögel," from which some of the illustrations in the present book are taken, fails to show that its text furnishes the groundwork for "Cassell's Book of Birds."

Having thus justified, as we hope, our doubts as to the "Book of Birds" originating from "the eminent Dr. Brehm," we must further express our doubts as to Prof. Jones being the translator and adaptor of it from the German of another naturalist of the same name. Here our doubts, it may be thought, do not rest upon so satisfactory a base; but the meritorious work by which Prof. Rymer Jones is best known, his "Outline of the Animal Kingdom," shows that its author is gifted in no common degree. The character of Professor Jones's volume was and is caution and accuracy, the character of the "Editor's Introduction" to the "Book of Birds" is the reverse. Here is an example. Its writer says (p. 17): "In order to render the following account of the structure of a bird's skeleton intelligible to the non-scientific reader we have delineated that of the Goose," and a reference is added to "Fig. 12," which faces these words. Now we scarcely expect that we shall be believed, but it is an undoubted fact that there is no figure of a Goose's skeleton at all, and that "Fig. 12" represents the skeleton of a bird so entirely different as a Pigeon; while so far from the inference being true that the editor has "delineated" the subject for the express purpose of enlightening his readers, we must declare that the woodcut in question is a very bad enlargement of what has been for years a stock-figure in anatomical handbooks. We do not pretend to know its origin, but we have now before us a far better copy of it in a Swedish work,\* and it has been repeated in many other books. That Prof. Rymer Jones has been guilty of such a blunder, to say nothing of such a *suggestio falsi* as this, we hold to be incredible. Again we have close by another woodcut (p. 22), which we are told represents "A young chicken shortly after its escape from the egg." Now we cannot believe that such an explanation was written by Prof. Rymer Jones, for he must well know the figure to be that of a young Blackbird assuming the first or nestling plumage, as it is rightly said to be in the "Catalogue of the Physiological Series" of the Museum of the College of Surgeons, where (vol. ii. Part II. p. 312, pl. xlv. fig. 4), the original of the woodcut may be found. Those who can believe that Prof. Rymer Jones does not know the difference between a Goose's skeleton and a Pigeon's, and between a Chicken newly hatched and a Blackbird just about to leave the nest, may believe it, we unhesitatingly declare we do not.

But it might be urged that all these matters are of little

\* "Grundlinier till Zoologiens Studium," af Karl Torin. (Stockholm, 1870) 3d ed. i. p. 87.

consequence; that 12,000 birds obviously cannot be figured in 400 engravings, and the statement was only intended to mean that the work is profusely illustrated; that English readers do not care a button whether there are as many Brehms as birds, or what books they write; and that diabolical agency in the press may blunder as to woodcuts or their explanations. Suppose we grant all this, and consider the rest of the work. We have expressed doubts as to the authenticity of the "Editor's Introduction," but even if they are rightly founded, the affair may be condoned should the translator and adaptor have performed his task well. We imagine that the first duty of a translator is to give an exact rendering of every phrase or name in the original, and it becomes necessary to see how far this has been done in the present instance. If there is a foreign bird well-known in this country, it is the common Grey Parrot—here we are taught to call it the "Jako" (p. 35), which may well be its German name but is not an English one. So also the great South-American group of Tanagers are throughout (pp. 150-155) "Tangaras." A similar case is that of the Serin, which is left (p. 106) under its Teutonic appellation of "Girllitz," which common German idiomatic term is comically rendered (p. 107) "a little pair;" and the British public has to find out as it best can that by "Tree-Falcon" (p. 305) is meant our well-known summer visitant the Hobby, though under the latter name it has flourished for hundreds of years. Indeed, the translator's ignorance of his subject is manifest on almost every page, but nowhere is it so remarkably displayed as when he introduces (p. 50) the word "Dronte," without the slightest apparent perception that by it is meant our old friend, the Dodo! Further proof of his incompetency for his task is shown by the mistakes (which cannot all be misprints) in the names of naturalists; thus we have "Jerdan" (p. 30) for Jerdon, "Speke" (p. 39) for Spix, "Boja" (p. 126) for Boie, and "Nardoi" (p. 300) for Nordvi. That a corresponding indifference to the niceties of scientific nomenclature should be exhibited is, of course, to be expected; but, setting aside such untechnical forms as "*Corys alauda arborea*" (p. 204) and "*Cecropis-Hirundo-domestica*" (ii. p. 105), we can hardly think that Dr. Alfred Brehm could have ever said that Linnæus named a bird *Derotyplus accipitrinus* and *Derotyplus coronatus* (p. 42), and we must suppose that the original sentence has been misunderstood.

Another instance, if another be wanted, to prove the inaptitude of the translator for his work, is the confusion existing in his mind between words like "variety," "race," "tribe," "family," and even "order." However much naturalists may differ as to the limits or value of the groups thus designated, all are expected to have clear notions as to what the terms mean. The translator of the "Book of Birds" jumbles them together, and thus raises fresh doubts as to his identity with Prof. Rymer Jones. We have "varieties" spoken of (p. 92), where species are clearly meant; "race" (p. 55 and p. 150), when something at least as comprehensive as a family is intended; "tribe" (p. 47 and p. 122) without any definite meaning at all; and "family" (p. 43 and ii. p. 136) in a sense as obscure; while "order" is used so vaguely that in one place (p. 23) it includes all the parrots and some other birds, which last, when they come to be described (p. 83) are spoken of as

forming an "order" of themselves, so that we have an "order" within an "order," whereat our reader will probably exclaim "Disorder!" Dr. Alfred Brehm may have some queer ideas as to classification (of which more immediately), but we feel sure he never committed such a high crime and misdemeanour as this.

Having thus noticed some of the shortcomings of the translator, we must say a few words on the author's treatment of the subject. We have just referred to his ideas on classification, but it is not easy to ascertain what they really are, for no scheme of arrangement is given. Enough however is to be gathered to show that they are somewhat peculiar if not original. We do not quarrel with him on this account. In the present state of ornithological science, its teachers, as well as its students, may well be pardoned for not adopting any plan already promulgated; but in a work intended for "everyone who wishes to know all that is known about birds," it is only reasonable to expect that the projects of prior systematists should receive some attention, and due cause shown why such and such arrangements are inadmissible or the contrary. Now we cannot find anything of the sort here. It is true that the author begins by remarking (p. 23) that it is usual in most ornithological works to place the Vultures first, but they are "the most disagreeable and least intelligent of the race" (admirable and philosophical reasons for depositing them!), and he recognises in the Parrots the "qualifications most fitted to entitle them to take precedence." For them accordingly he constitutes a "distinct order under the quaint but expressive names of Crackers (*Enucleatores*)"—we will not copy the printer's bad spelling of the last word. Many ornithologists will so far agree with Dr. Alfred Brehm, but we read on, and to our surprise find that this order is "by no means limited to the parrots; it includes various other seed-eating birds, chiefly belonging to the passerine tribes, the resemblance of which to parrots has been in some cases generally acknowledged in selecting the names ordinarily conferred upon them. Thus, the Crossbills have long been known in Germany as the Fir-tree parrots, and, on the other hand, the epithet of Sparrow-parrots, applied to some races of climbing birds, clearly shows the relationship that exists between these generally dissevered groups." Yet a few words more are needed before we conclude.

There is Science, and Science falsely so called. It is a rank offence to give the stone of science falsely so called, instead of the bread of true science, and this is what all concerned in the present work must be held to have done, while to back up the imposture by assertions which are palpably or presumably untrue, is an aggravation of the crime, and like all crimes, its commission is a mistake. There is no more erroneous belief than that a book to be popular cannot be scientific, for numerous are the scientific books which have attained to a high degree of popularity. But scientific books are under a heavy disadvantage when they have to struggle for existence amid a growth of specious pretenders. The young beginner full of enthusiasm knows not at first to distinguish the wheat from the tares which surround it. The duty, therefore, of everyone who does know the difference, is to point out and bind the tares for the burning, and in doing this he must not shrink from expressing his opinion of those who sow them. We have heard it said that it matters

not how rubbishy a book of Natural History may be, for, provided that it be of such a kind as to command a large sale, it must foster a taste for the subject among the million. This is a most pestilent doctrine. If the tares occupy the ground, how can the wheat grow? and the publication of every book of spurious science precludes the publication of a really scientific book on the same subject.

#### OUR BOOK SHELF

*The Arts in the Middle Ages, and at the Period of the Renaissance.* By Paul Lacroix, Curator of the Imperial Library of the Arsenal, Paris. (London: Chapman and Hall, 1870.)

A TASTE for art usually comes to us somewhat late in life, because, in nine cases out of ten, the taste is not cultivated or developed till long after school life. We have, in fact, no regular art education in this country, although endeavours are being made at South Kensington to form Art Schools, and to accumulate art students. A love for high art is certainly more common in France and Italy than in England, and this is partly accounted for by the fact that some education in the first principles of the arts is given in all the government schools and colleges. The work before us is well calculated to foster such tastes. It discusses not alone the principal arts:—"We pass in review," says M. Lacroix, "all the Arts, starting from the fourth century to the second half of the sixteenth. Architecture raising churches and abbeys, palaces and public memorials, strong fortresses, and the ramparts of cities; sculpture adorning and perfecting other arts by its work in stone, marble, bronze, wood, and ivory; painting, commencing with mosaic and enamels, contributing to the decoration of buildings jointly with stained glass and frescoes, embellishing and illuminating manuscripts before it arrived at its highest point of perfection, with the art of Giotto and Raphael, of Hemling and Albert Dürer; engraving on wood and metal, with which is associated the work of the medallist and the goldsmith; and after attempting to touch upon playing cards and niello-work, we suddenly evoke that sublime invention destined to change the face of the world—Printing." Although M. Lacroix speaks above of passing in review *all the arts*, we notice at once that he has mixed up the fine and the useful arts, and omitted some of each of them. Moreover, he has chiefly discussed what we call the "decorative arts." Poetry is omitted altogether, and the only account of music is given under the heading "Musical Instruments."

The book itself is gorgeous. It is well printed, and is full of good engravings and woodcuts. Moreover it contains nineteen excellent chromo-lithographs, by Kellerhoven, the most notable of which are the sixth ("Biberon of Henri Deux Faience") and the thirteenth ("The Dream of Life," a fresco by Orcagna). We have no book in our own language which satisfies the want, which must so often have been felt, of a work of this nature. It is a positive art-educator, and what with the appointment of Professors of the Fine Arts at Oxford and Cambridge, and the appearance of a few works of this kind, we may hope before long really to possess in this country some critical taste for all that is beautiful in art.

G. F. R.

*Descriptive Travel and Adventures; or Hubert Preston Abroad.* By Catharine Morell. Edited by J. R. Morell, formerly one of Her Majesty's Inspectors of Schools. (London: T. Murby.)

We hope this is not a sample of "The Consecutive Narrative Series of Reading Books," of which it appears to be the 6th volume, for the sake of the unfortunate youths

in whose hands they may be placed. We scarcely know a book which we should take greater pains to keep out of the hands of young people eager for knowledge. It is full of the grossest and most palpable blunders. We will quote the three first we came across, giving chapter and verse, as we hardly expect to be believed without affording our readers the opportunity of verifying our quotations for themselves, if they wish to. When we read (Chemistry, p. 83) that "quicklime is simple carbonate of lime taken from the limestone of your mountains!" we thought we had pitched upon a curious slip of the pen; when we found that "marsupials," (which, by the bye, are known as being animals *that jump instead of run*) "are peculiar to Australia," and "*the tiger peculiar to the New World!*" (Growth of Plants, p. 173) we opened our eyes with astonishment; and when we were told that *the elephant chews the cud!!!* (The Elephant, p. 197), we closed the book in disgust. Surely any boy on the lowest form of any school which the gentleman who edits the book "formerly inspected," would have set him right on all these points. Seriously, it is very sad that at this time of day it should be found possible to circulate such rubbish under the name of instruction in science. If this is what is to come of inspecting schools, the less we have of it the better, till we have trained up a staff of inspectors acquainted with at least the rudiments of science. B.

#### LETTERS TO THE EDITOR

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

##### The Teaching of Science

I AM the principal of a private school. I have long taken an interest in science, and have, by proceeding very gradually and cautiously, succeeded in making Scientific Teaching for a limited time in the week a part of the regular school course. There are many more difficulties, however, in the way of this than some of your off-hand devotees of science seem to be aware of.

Not the least of these is the decided opposition of some parents, who object altogether to any portion of their sons' time being devoted to that, the direct practical use of which they do not see. My school may be divided into three classes; those who are preparing for one or other of the public schools; those who are preparing for special examinations at Woolwich, and those who will complete their education with me. The first two classes cannot afford to lose any time upon any subject that will not tell directly upon the examinations to which they are respectively looking forward, otherwise the result might be the loss of a scholarship in the one case, and in the other the loss of a place altogether. And how utterly void of all chance Science is, in the former case at least, you can well judge. So that until our Public Schools set us the example, it is very little scientific teaching that we can give to this class of pupils at all events. While with regard to the last class, all that parents wish is that their sons should receive a classical and general education; but any meddling with Science I can assure you some of them look upon as simply an amusement of the master's, obtained at the expense of their sons' time. Nevertheless, as I have already said, I have made Scientific Teaching a regular part of the school course for a short time every week, and am only prevented from extending it much further by the causes named above. The subjects we have taken up hitherto have been elementary physiology and chemistry. For the former we have used Dr. Mapother's "The Body and its Health," while one or two of the elder pupils have gone on to Huxley's "Elementary Lessons in Physiology." And when it is considered that the average age of our pupils is only about twelve or thirteen years, I think this is as much as could be expected. For chemistry, we have been very much puzzled to find a suitable text-book; for though there is no want of really first-class books, we have not been able to obtain what we wish. Both Wilson's (published by Chambers) and Roscoe's "Elementary Lessons" are too long, and (considering the objections of parents named above) too high in price for school boys. What we want is something about half the size

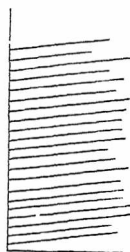
and price of either of these, which might be made the ground-work for lectures. As it is, we have been compelled to depend upon lectures alone, illustrated by experiments, in which the pupils themselves are allowed to have as much share as possible. I should be much obliged to any of your readers who could direct me to any text-book likely to meet the want I have indicated. We are now intending to combine with the subject named above a little Natural Philosophy; and I may add, that we have already had, some time ago, a twelve months' course on electricity, with experiments.

I think, however, that the whole subject of Science Teaching in schools wants treating by some master hand; and if some such man as Prof. Tyndall, for instance, who, in addition to the highest scientific attainments, knows something about the practical difficulties of the matter, would enter into the whole subject in your columns, advising what to teach, how to teach it, and what books to use, he would, I am sure, confer a real benefit upon Science. We have heard enough about the want of it; we want now to be told by competent authority how the want may be best supplied. And I am able to say from my own personal knowledge that there are heads of schools quite convinced of the importance of the subject, but utterly ignorant how to set about remedying it. Upon this point I wish to be very emphatic, and indeed it was chiefly for the purpose of urging this that I began this letter, knowing as I do well, both from observation and experience, the practical difficulties of the subject; difficulties which are much, very much, greater than your enthusiastic philosophers have any idea of. I hope, however, that if the subject be taken up at all, it will be by some one practically conversant with it, who can give advice which will be worth taking.

M. A.

#### Forms of Clouds

CLOUDY formations worthy of being noticed have been observed by me during the week. On the 8th I chanced to take a walk with M. Gustave Flourens, who has since been sentenced to death by court-martial. At five o'clock we witnessed many ribboned clouds parallel to each other, and so long that they appeared to radiate from a common focus. These ribboned clouds terminated abruptly just over our heads, and their extremities were *noalescent*, so that the appearance was one of a feather with the vanes of the quill emanating from one side. The wind was blowing



perpendicularly to the vanes and parallel to the quill. This accumulation of matter was evidently owing to the purity of the air on the other side of the singular cloud-edge.

I witnessed again these phenomena on the 9th and on the 10th of March, but not so well. On the 9th and 10th I also observed two solar halos well defined. The halo had a peculiarity of its own. The clouds adjoining the edge were tinged most delicately with violet on the south-easterly side. The evening was stormy and rainy, which is consistent with the theory I have advocated that halos are a prognostic of bad weather.

W. DE FONVIELLE

#### The Limits of Numerical Discrimination

THE solution of the Problem "how many objects can a man count at once?" is not general, but depends especially on the grouping, position, angular distance, similarity and nature of the objects counted, as well as on the experience and health of the person who counts them.

(This is written under the supposition that the word "count" means "tell the number of," not "begin, one, two, three," which of course cannot be done simultaneously.)

As an example of the operations performed in counting, take the card "ten of diamonds." The player passes his eyes up and down it, recognises it to be the ten, discriminating it from the other cards, calls it by its name "ten," and then, if he likes, can count separately the pips on the card.

This is a case in which the number of the card is recognised as its name, and many others could be adduced in which much higher numbers arranged symmetrically could be recognised at a glance without counting.

A person habituated to counting would divide the objects into groups with which he was best acquainted, in a way depending on their position.

To show that running the eye over the object is not necessarily conscious, or the very operation of counting—If anyone on a fine sunny day looks through a latticed window for some time and then shuts his eyes, he will be able to count a great number of panes in the impression on his retina, or wherever it is. (Compare with this operation that of recognising a person after he has passed out of sight.)

Looking at a collection of objects in counting by groups is governed by the same laws as looking at a single complex object, and naming follows after the object has been properly discriminated. I can imagine that a person naturally gifted with a memory for form of a certain kind, could by practice at once recognise the number of a large quantity of coins scattered at random, inasmuch as the number would be sharply discriminated from the one higher and the one lower, just as a shepherd discriminates sheep, which to other eyes are alike, and if he can discriminate 36 from 35 and 37, there is no necessity for him to count 36 to say that 36 are there. That can be done afterwards. There should be no astonishment that anyone should possess this power, for after all what is it in comparison to the marvellous faculty we have of seeing highly complex objects at once, which we can analyse to a certain extent; but in no way resolve into the elements of the synthesis. The discrimination between red and yellow, between one note and the next, seems to demand much finer powers of the memory; but we are not astonished at it.

The explanation of many wonderful mental and manual feats depends on the same marvellous faculty of apprehending and considering as one that which formerly could be only considered as very many. Reading words, playing a musical instrument (whether with or without notes), writing, tying knots, doing needlework, the manufacture of every useful thing, all are acquired through the same faculty of changing several simple movements into one complex movement, which is treated as one, and can be named as one, even before it is analysed. It is only fair to infer that counting by groups is an art which may be learned, and, if worth the while, carried to a high degree of practical excellence.

Your correspondent "J. B." (March 9) illustrates Dugald Stewart's view by the examples of two beans and two eyes; these do not prove anything in regard to mental attention, but only that they were not both opposite the parts of the retina with which the observer could see most comfortably. If they had only a small but perceptible angular distance, and did not dazzle so as to tire the eyes, what he mentions would probably not have occurred. He could remember them both together and then count them as well as if he were actually looking at them.

Eccles, March 14

R. V.

#### Books Wanted

COULD you kindly inform me where I could obtain the following works mentioned by Sir John Herschel in his "Discourse on Natural Philosophy," viz.—Bracconot, "Annales de Chimie," and "Dr. Prout's Account of the Experiments of Professor Autenrieth, of Tubingen," Phil. Trans. 1827. My efforts to obtain these books have hitherto been in vain; if you could assist me, I should feel much obliged.

Newbridge, March 12

H. J. WATSON

#### Quinary Music

YOUR correspondent, Beacon Lough, will find a very effective specimen of this division in the concluding Allegro to the glee "The Gipsy," written by Wm. Reeve. W. R. M.

#### The Earthquake

THE earthquake, which caused considerable alarm throughout the North of England on the night of the 17th, was felt severely here between 11.5 and 11.10 P.M. The sky, which had been

overcast during the evening, suddenly cleared up towards 11 P.M., but was again completely covered at 11.15. The barometer was heaving during the night, but no special disturbance is registered on the photographic curve; the corrected reading at 11 P.M. was 29.887, and 29.885 at 11<sup>h</sup> 11<sup>m</sup>.

The rise of temperature was rather sudden just before the passage of the earth-wave, attaining its maximum, 43.4° at 11<sup>h</sup> 11<sup>m</sup>, the wet bulb being then 42.4.

For most of the afternoon the wind was W.S.W., and was changing from W.N.W. to S.W. between 11 P.M. and midnight; at the time of the shock it was due W. It was blowing gently at the average rate of some thirteen miles an hour from the previous midday, and at scarcely four per hour after midnight. At 10 P.M. its velocity was nine miles an hour.

The trace on the magnetic declination curve shows that the magnet was moving rather rapidly from W. to N. when the shock occurred, and a slight irregular movement at 11<sup>h</sup> 11<sup>m</sup> may be due to the earthquake. The magnets were very quiet before 10 P.M., and disturbed from 10 until morning.

The shock was felt very generally throughout the neighbouring villages.

The sound is generally described as that of a strong gust of wind, followed by a noise resembling the passage of an express train over a wooden bridge. This was followed by a very distinct rocking of the furniture, beds, and walls; the whole of the houses seemed to shake violently, and the floors to rise; the rooms swayed backwards and forwards several times. The motion was violent enough to awaken persons from their first sleep. Many thought that part of the building had fallen in, or that something heavy had tumbled down in a room over-head. The rushing sound and crash were followed by a rumbling noise. The motion appeared to begin suddenly, to grow stronger for a time, and then to die away. It was more regular and powerful than the shaking from a heavy waggon in the houses of an old street.

The time the whole disturbances lasted is generally estimated at about half a minute; but this, I should be inclined to think, is excessive.

The direction of the motion is supposed by most to have been from E. to W.

S. J. PERRY

Stonyhurst College Observatory, March 20

ALL who are acquainted with the North of England are aware that the districts comprising the counties of Northumberland, Durham, and Yorkshire, are physically divided from that occupied by those of Cumberland, Westmoreland, and Lancashire by a ridge or watershed, formed by the Pennine chain, which is a range of hills averaging 1,700 feet in height, composed of Lower Carboniferous strata, through the centre of which runs the Pennine or "Anticlinical Fault," which has the effect of throwing the strata in a downwards direction to the east and to the west, like the slopes of the ridge of a roof of a house.

To the west of this ridge, in Lancashire, are low undulating plains of Coal measures, and Triassic rocks, much faulted and covered with glacial drift, and in Cumberland and Westmoreland the high mountains and deep valleys of the Lake District intervene between it and the sea. These mountains, composed of Silurian rocks, existed as such, long before the anticlinical fault heaved the Pennine chain into existence, and long before the Oolite strata, forming the high Yorkshire Wolds on the eastern side of the watershed were deposited at the bottom of the sea. In the West Riding the moors have been cut, by the long-continued action of running water, into the deep ravines, or vales, which form so characteristic a feature of that district. It is an interesting question to observe how far this general arrangement of country, and the strata of which it is composed and the dislocations which the latter has suffered, appear to affect the direction, localities visited, and the distribution of the lines of greatest intensity, of the earth-wave which visited the northern counties on the night of the 17th inst. The tract over which it was felt, as far as at present known, would be comprised within a circle, with a centre about ten miles due east of Sedburgh, the diameter of which would be a line drawn from Dumfries to Doncaster, the farthest limits to the north-west and to the south-east, respectively, to which the earth-wave extended. The greatest effects appear to have been experienced in a belt, about thirty miles broad, running inside this circle, the inner margin running along the towns of Scarborough, New Malton, York, Leeds, and Bradford, Preston, Longridge, Kendal, Penrith, Carlisle, Newcastle, and Sunderland, and thence probably passing out to sea

and curving round to Scarborough. The outer margin, or circle before mentioned, runs by the Humber, Doncaster, Manchester, Salford, Roby, Huyton, Seaforth, Southport, and probably for some distance out to sea, Blackpool, west of Ulverstone and Coniston Lake, Dumfries, by the north of Tyneside, to the sea. If this belt be drawn on a map, it will be seen that that segment of the circle which occurs from Sunderland to Scarborough, falls entirely out to sea, and up to the present time the earthquake is not known to have been felt on that coast between these points. It would therefore appear probable that this earth-wave traversed the country in a circular belt, the entire north-eastern segment and the outer margin of the Lancashire portion being beneath the sea; that the area of greatest intensity was near the inner margin, but especially at Preston, Lancaster, Ulverstone, and Blaydon, near Newcastle; that the area in Yorkshire, within this belt, was not entirely free from the shock, as it was slightly felt in Wensleydale and Swaledale, on the eastern slopes of the Pennine chain.

At Preston, where the earthquake occurred at 11.4 P.M. Greenwich time, the motion I observed to be from south-east to north-west; the oscillation was considerable, and the hollow noise, which commenced and ceased with the vibration, resembled express trains running in underground tunnels. The air was close and oppressive, the wind S.W., the night starless and hazy, and the sky from the N.W. to the N.E. covered by a peculiar glare, resembling an incipient aurora, which lasted until 1.30 A.M.

In several places more than one shock is reported to have occurred: thus at Singleton Brook, Manchester, the first shock occurred at 10.56; the second, lasting two seconds, at 11.5; and the third, lasting four seconds, half a second after. Two shocks near together were also felt at Leeds, the second being the sharpest, which was felt at Armley, Headingley, Woodhouse, New Leeds, Chapelton, and West Bar. Two shocks also occurred at Kendal, the first at 6.20 P.M.; the second, which was the most severe, at 11.15, lasting twelve seconds, that experienced by myself at Preston lasting about seventeen. From Grasmere also three shocks are reported, the first being at 6.40, and the second and worst at 11 P.M. At Ambleside, the first shock was also felt at 6.30, the true time probably of the two noted above, the second being at 11.3 P.M. At Coniston, a slight shock was felt at 7.0 P.M. on the 17th, and another at 6.3 A.M. on the 18th.

At Hexham, the chief shock is recorded as taking place at 11.15; Ambleside, 11.3; Ulverston, 11.5; Preston (by myself), 11.5; Bowdon, Manchester, 11.4; Singleton Brook, Manchester, 11.4; Newcastle, 11.30; Leeds, 11.15; Penrith, 11.4; Liverpool, 11.15; Kendal, 11.15; from which it will be seen that localities, comparatively near together, often differ more as to the time of occurrence than some of those far apart, and thus there is, therefore, strong reason to believe that these various observations (from 10.30 P.M. to 11.30 P.M.) represent one shock, occurring practically at the same moment over the whole area about 11.5 P.M.

In the year 1786, on August 11, an earthquake which extended over nearly a similar area to the present, like it, slightly displaced the waters of Windermere and the Lake District was felt; and the same district was also visited by an earthquake on Feb. 22, 1867, which was particularly felt on the north shores of Morecambe Bay. It is curious to observe that the northern margin of the area of the earthquake, which was felt over the greater part of central and southern England, in 1863, exactly coincides with the southern margin of the present, and that the latter, in its course to the north-west, directly crossed the Pennine chain in two places.

H.M. Geological Survey,  
28, Jernyn Street

C. E. de RANCE

On Friday night last, March 17, at 11 P.M., we had a slight shock of an earthquake. I was reading, when suddenly I imagined I heard a carriage and pair drive rapidly up to the house, then rapidly drive on, there being a pause of half a second at least between the two rumbling sounds. After the second sound had continued a second, the house began to shake to such a degree that I rushed out of doors. The only damage done was that all the ceilings on the ground floor show cracks in the plaster. No doubt you will hear more of this from other correspondents.

GEO. H. SAVAGE

Nent Head, Alston Moor, Cumberland

Lunar Halos: their Origin and Prognostic Significance

M. W. DE FONVIELLE is, no doubt, right in attaching importance to the study of these phenomena of refraction, depending as they do, upon the polarisation of atmospheric vapour. Rightly interpreted, they afford one of the most certain indications of weather change, especially in regard to rain; but the popular notion of their being precursors of storms is certainly exaggerated. In reply to hee inquiry made by M. de Fonvielle, I may say that the distance between the observers of the singular forms of this phenomenon, and seen on January 4th (and of which a sketch, furnished by me, was inverted by the printer) was about two statute miles. I have ascertained that the two arcs in my own sketch corresponded with the largest and the smallest circles in the drawing of your other correspondent. I saw nothing of the intermediate intersecting arc, almost vertical\* in his drawing.

M. de Fonvielle does not, however, remark on the fact that the great circle of 90° had the moon in its *circumference*. Allow me also to add that in my own sketch the apparent diameter of the moon and of the imperfect paraselene are exaggerated; the object of the drawing being to show the relative magnitude and position of the two circles. The innermost circle in both drawings was about 45° to 50°—in fact an ordinary lunar halo. All my observations (for many years) have pointed to the inference, which I may call a law, "That halos indicate a change of temperature, and are indicative of transition from dry to wet as well as from wet to dry." I shall be happy to forward M. de Fonvielle further information if desired.

Aigburth, Liverpool, March 20

SAMUEL BARBER

Science in Schools

In the last number of your paper a correspondent, "W.," asks for information respecting "any school adapted for young boys whose parents wish to give them an education embracing the physical sciences and modern languages, on some such plan as that of the Realschule of Germany." Will you permit me to state that the International College at Spring Grove was established with precisely this object, and to a prospectus of this college, which I send you, I would direct the attention of your correspondent. The scheme of science instruction for this college was drawn up by Professors Huxley, Tyndall, and Williamson, and for upwards of four years past has been carried into operation as closely as circumstances permit.

Isleworth

W. F. B.

In reply to "W." will you allow me to forward you a prospectus of Craufurd College, Maidenhead, in which an education is given embracing the physical sciences and the modern languages. Having many years ago visited the Realschule of Offenbach, and attended the classes of several of the professors in that school, I have no hesitation in expressing my opinion that a comparison of the merits of the two schools would not be unfavourable to the former.

ANGLICUS

Morell's Geometry

As a considerable part of your number of February 23 is devoted to comments on a little publication just issued by me, "The Essentials of Geometry," I must request you in courtesy to insert these lines in order to set right one misconception. "The Reviewer" (p. 323) passes certain criticisms on the definitions and enunciations, as well as demonstrations, of the book, describing the former as having salient incongruities, and the latter as being nonsense. These are strong expressions, but my present purpose is not to expose the fallacy of the remarks in the review, but to point out the fact noticed in the preface, and overlooked by the reviewer, that all the proofs in the work are taken from French and German sources (p. viii.)

I may add that those sources are the most approved in neighbouring countries, and though I have not given my references in every case, I have done so in so many cases that any person of ordinary discrimination might have inferred that every statement and proof advanced had some high authority for warrant. It is to be regretted that the "Reviewer" overlooked this, for in his haste to condemn a method for which he has an antipathy, he has been betrayed into accusing some even of the leading British as well as foreign geometers as guilty of salient incongruities, and of writing nonsense. Thus the definition of a plane angle, though

\* See NATURE, Jan. 26.

condemned by "The Reviewer," is almost identical with that of Dr. Thomson in his edition of Euclid (1835), Def. 7, and the Note to it which runs: "A rectilinear angle is the degree of opening or divergence of two straight lines which meet one another." Nor does Euclid's original definition of an angle differ in conception from that given by me, *γωνία ἐστὶν ἡ πρὸς ἀλλήλας τῶν γραμμῶν κλίσις*; for this word *κλίσις* contains the notion of revolution, that is, of more or less. Compare my second definition of an angle.—*Essentials*, No. 68, p. 40.

Again, the enunciation and demonstration of the two fundamental theorems of parallels are qualified as sheer nonsense, and yet the whole passage is textually the same as Amiot's, including the parts printed in italics. Further, the proof of the equality of triangles at p. 44, condemned as a violation of the common rules of logic, is based on the previous pages 42, 43, overlooked by "The Reviewer," and agrees almost word for word with Legendre, and absolutely with M. Bos, Professor of the Lycée St. Louis at Paris, and successor of Amiot. (See his "Memento du Baccalaureat es Lettres," 1866-68, p. 183. *Partie Scientifique*.)

It would take up too much time and space to go further into the matter in dispute, but I wish it to be clearly understood, without denying the right of "The Reviewer" to attack the book in any way that is fair and reasonable, that it is neither one nor the other to make Mr. Morell the object of all the attacks when he is far too honoured in being treated as the substitute for many of the first geometers of the present age on whom the punishment descends.

Every statement and proof in the work has for its warrant some high authority, and the basis of the work and most parts of it to which no special references are given in foot-notes are taken from a digest published by University examiners and Doctors of Science on the Continent.

Now, Sir, as the present letter does not presume to enter on a discussion of the merits or demerits of the work, but is simply an explanation of an essential point underlying the whole question and overlooked by "The Reviewer," I must, as I have said before, request these remarks to be inserted in NATURE to set right the mistake about the authorship and authority of the book.

If NATURE will have the courtesy to give me a little more space on a future occasion, I hope to show on my own authority that I have good arguments for what has been advanced.

March 15

J. R. MORELL

Work and Force

As I hope to hear more of Mr. Highton's arguments at the meeting of the Literary and Philosophical Society of Manchester before this is printed, I will content myself now with noticing but two points.

The first is his attempt to defend himself from the charge of confusing Work and Force; there are other passages in his writings which lead to this somewhat serious conclusion; but the vagueness of the expression "the total of the force used" would suffice to make anyone suspect some such confusion. I presume that a "total of force" is still force, and can therefore be no more equivalent to work than to a time or a space.

The other point is the sentence "this only shows that one of the laws of thermo-dynamics is inconsistent with the doctrine of the mechanical equivalence of heat." If Mr. Highton knew that the first law of thermo-dynamics simply asserted this equivalence he would surely have expressed the proposition differently. As it stands in form it is very much the same as if he had said that one of Newton's laws of motion was inconsistent with the principle that a particle acted on by no forces will move uniformly in a straight line.

If he had known what the laws were, he would hardly have said that they were inconsistent with the very principle which the first asserts, and which the second, as usually stated, involves.

Of course, these lines are not meant as an answer to Mr. Highton's letter, but merely to show that he really does not quite understand the theory he criticises.

March 18

J. HOPKINSON

INVINCIBLE ignorance is said to be excusable. This must be my plea, when I say that I have read over again Sir W. Thomson's paper in the "Philosophical Magazine" of Feb. 1854, and that I cannot see but that it leads to perpetual motion more than anything I have ever written.

H. HIGHTON

## AMERICAN NOTES

WE are again indebted to the early sheets of *Harper's Weekly* for the following:—At a late meeting of the Boston Society of Natural History a communication was presented by Count Pourtales in reference to the character of the sea bottom off the coast of the United States, south of Cape Hatteras, and based upon the researches of the Coast Survey. According to his statement, the principal constituent of the coast is silicious sand from the coastline to about the line of one hundred fathoms—a limit which coincides nearly with the inner edge of the Gulf Stream throughout the greater part of its course. Outside of this line is a whitish calcareous mud, containing globigerina, and extending probably over the greater part of the ocean. South of the Vineyard Islands, and to the eastern end of Long Island, the silicious sand is replaced by a kind of bluish mud, known as the Block Island soundings. A similar mud is found off Sandy Hook in a range of depressions known as mud holes, which form a leading mark by which to find the port of New York in thick weather. A few rocky patches are found east of the neighbourhood of New York, and a rocky bottom occurs, sparingly, near Cape Fear; but otherwise the sand is pretty uniform, varying only in the size of its grain. On the inner edge of the Gulf Stream there is a deposit of greensand composed of the cast-off foraminifera.—According to late advices from Florida, Mr. N. H. Bishop, whose visit to that State in the interest of natural history we have already referred to, has started off in his yacht on a cruise down the coast for the purpose of making collections of Florida birds, &c. He hopes to penetrate into the Everglades and prosecute some inquiries in regard to certain species of birds said to occur there, and no where else in Florida.—We regret to have to record the death, at St. Paul, Minnesota, on the 13th of December last, of Prof. William Chauvenet, formerly Chancellor of Washington University, St. Louis. This gentleman has long been known in American scientific circles for his attainment as a mathematician and astronomer; and the various works published by him have occupied a high position as text-books and manuals of instruction. For a time connected with the Naval Academy at Annapolis, he was subsequently elected Professor of Astronomy and Mathematics in Washington University, St. Louis, afterwards becoming Chancellor, and remaining there until 1869. His death occurred in consequence of exhaustion of the nervous powers at the age of a little over fifty.—We regret to learn that in the course of a disastrous fire at Springfield, Illinois, on the 25th of February, the collection of the Geological Survey of the State of Illinois was in large part either destroyed or greatly injured, especially the fossil plants. This loss is the more severe, as the collection in question contained one of the finest series of Carboniferous fossils in the country, and embraced a large number of types of new species described by Messrs. Worthen and Meek. This should be a warning to all who have charge of valuable natural history collections, to give themselves no rest until their treasures are secured in fire-proof buildings.—We recently called attention to the excessive degree of cold to which meteorological observers on Mount Washington have been subjected during the present winter. Since then still greater inclemency has been recorded, during which the thermometer was fifty degrees below zero, while the wind had a velocity of one hundred miles an hour.—We have already, in a previous number, referred to the examination of a locality in California, by Prof. Marsh's exploring party, where numerous fossil trees had previously been discovered; and we learn that a detailed report may be looked for in the April number of the *Journal of Science*. The region in question is situated on a high, rocky ridge in Napa County, California, near Calistoga Hot Springs, and about ten miles from the summit of Mount St. Helena. The ridge itself belongs to the Coast Range series, and forms the division between the Napa and Santa Rosa valleys. It is about two thousand feet in height, and is composed of metamorphic rock of the cretaceous period, overlain unconformably by later tertiary strata, consisting of light-coloured, coarse sandstone, and beds of stratified volcanic ashes. A careful examination showed that the trees on the surface of the ground had been weathered out of the volcanic tufa and sandstone, and consequently were of the Tertiary age; and also that there remained still embedded in the volcanic tufa, &c., an extensive forest of very large trees, stretching over a great area. Some of the trees were of great size, a portion of one having been traced for a length of sixty-three feet, with a diameter of seven feet near its smaller end. Another tree indicated an original diameter of not less than twelve feet. All were prostrate, and had apparently been thrown down by the volcanic

current which covered them. Many were much decayed internally and worm-eaten before they were buried. All of the wood was silicified, probably by means of hot alkaline waters containing silica in solution—a frequent result of volcanic action. A careful examination of the wood obtained at this locality showed no essential difference in structure from that of the modern redwoods of California (of the genus *Sequoia*). No other fossils were met with, which rendered it somewhat difficult to fix the precise epoch; but it is considered probable by the Professor that the trees belonged to the Pliocene period. The origin of the volcanic material which covered the forest could not be ascertained, although it was supposed to have been derived from Mount St. Helena, which is the nearest volcanic peak.

## THE SCIENCE AND ART DEPARTMENT

WITH reference to examinations in large towns, the Department had previously issued the following regulation:—"In large towns or populous districts where there are three or more schools, and where numerous examinations are to be held, the Science and Art Department *may at its discretion require* a special local secretary to be appointed to manage the whole of the examination business. The Department will correspond with him alone on all subjects connected with the examination. He will be allowed a fee of ten guineas, and an extra fee of half a guinea for each night on which an examination is held."

The Department has now determined to place the conduct of these examinations as far as possible in the hands of officers appointed by the School Boards with the approval of the Science and Art Department. In such cases the School Board would determine, in concert with an Inspector from the Science and Art Department, the centres at which the examinations were to be held. They would appoint officers, one of them as special local secretary, with such a staff of assistants as would secure the presence of at least two, or if the number of candidates were very large, more officers at each examination. The examination papers would be sent to the officers appointed by the School Boards as they are now to the Local Committees. While these officers would be responsible for the conduct of the examinations, it would be expected that a few members of each of the Local Committees would visit the examinations and satisfy themselves with regard to the pupils of the classes they superintend. The same payment will be made to the special local secretary appointed by the Board as is now made to the special local secretary elected by the Committees; and they would make a payment to each assistant of 10s. for each night he was required to attend.

With regard to the number of Science Schools in which no fees are charged, or in which they are merely nominal, the Department thinks that the schools cannot be considered in a wholesome condition when students, a very large proportion of whom are adults in the receipt of wages, obtain their instruction wholly at the cost of the State and without any pecuniary contribution on their part. Nor is it probable that they will value as they ought what is given gratuitously. The directions in the Science Directory are very plain on the point. They state that "the payment of fees by the students can be looked upon as the only solid and sufficient basis on which a self-supporting system can be established and supported. Though the Department does not consider it necessary at present to lay down any rules making the payment of fees an absolute condition of the grants on account of Science instruction, yet as the payments from the State must be expected to diminish, and as aid on account of those persons who do nothing for themselves cannot be justified, committees of schools and classes and teachers are strongly urged (should it at present not be the practice) at once to impose as high a scale of fees as they consider can be raised not only on middle class students but also



on artisans." The Department desires to call the serious attention of the Committees of Schools to this instruction where fees are not imposed. They find that in some places not only is there an entire absence of fees, but that there has even been an unseemly competition on the part of teachers to get students by any means to join their classes with a view of earning the payments on results. They therefore give notice to the Committees of Schools that unless they themselves take steps to remedy the present evils by imposing at least some small fees, which should be paid to the Committee direct, it will be necessary to reduce the amount of the payments on results. They have no wish to reduce the payments on results at present, and they would avoid as long as possible the imposition of new conditions which necessarily complicate the system of aid, and render the rules burdensome and difficult to work under, but the want of proper vigilance on the part of the Committees may render this step necessary.

#### AUGUSTUS DE MORGAN

THOSE readers of NATURE who are in the habit of examining the obituary column of the *Times*, will have regretted to see, on Monday morning last, the announcement of the death of the eminent mathematician, Augustus De Morgan. He had been seriously ill for the past two years. A disease of the kidneys, complicated with other disorders, had reduced him to a shadow of his former self, and rendered him incapable of any protracted exertion. This was the more trying as his mind retained all its former energy, and the doctors forbade his reading more than an hour or two in the day. He was, however, allowed to see his friends, and often amused and instructed them by the hour together from the stores of his extraordinary memory. During the last few weeks he had become considerably weaker, and on Saturday the 18th, at one o'clock in the afternoon, his spirit was released from the body which for so many months had been only a burden to it.

Augustus De Morgan was the son of a Colonel in the Madras army. He could trace his descent from the mathematician, James Dodson, author of the "Anti-Logarithmic Canon." He was born in the summer of 1806, in Southern India. While yet a school-boy, he showed his taste for mathematics by filling thick notebooks with "infinite series," which he interspersed with grotesque figures and quaint faces. In 1823 he went to Cambridge, where he entered at Trinity College; his rooms were in the south-east corner of the great court, then called "Mutton Hole Corner," which he affirmed was a contraction from Merton Hall Corner.

In the tripos of 1827 he was Fourth Wrangler, but he never proceeded to the degree of M.A., owing to his objection to subscribe to the tests, and it is sad to think that the same conscientious scruples debarred this illustrious man from a Fellowship. On leaving Cambridge he entered at Lincoln's Inn, and would have forsaken Mathematics for the study of the Law, but that in 1828, the London University, now University College, was founded, and he was offered the Professorship of Mathematics there, which he accepted, and remained a firm supporter of the College and its principle of no tests till the year 1866, when the Council, in making an appointment to the chair of Logic and Mental Philosophy, refused, as the Professor believed, one of the candidates on account of his religious opinions. Prof. De Morgan remonstrated, but his remonstrances were disregarded. He then thought it his duty to inform them that he must forsake the College if the College forsook its principles. But the Council turned a deaf ear; and Prof. de Morgan, who had for nearly forty years been the chief honour and ornament of their institution, left them, and, we are informed, never afterwards entered their gates.

To estimate the energy of the Professor we must look at him not only as a teacher of mathematics, but as a mathematician, an actuary, a logician, an historian, a biographer, and a bibliophile. First, then, as a teacher of mathematics perhaps no man has been more successful in training distinguished mathematicians. Amongst the latter we may mention the names of Prof. Clifton, Judge Hargreave, Mr. Routh, and Mr. Todhunter. Prof. Sylvester also attended his lectures, though the relationship of professor and pupil did not in this case last very long. He had a method of interesting his hearers in the subjects on which he lectured, and of making them love mathematics for its own sake, which few other men have ever attained to. He expended a great deal of work upon his classes. The subject-matter of every lecture which he delivered was entered in a note-book and sent into the library of the college for the benefit of his pupils while writing out and expanding their own notes.

As a mathematician, his work was so various that it is difficult for any one man to review it, and it would be out of place to attempt anything of the kind here; but we may allude in passing to his double algebra, which was certainly the forerunner of Quaternions, and contained the geometrical interpretation of the symbol  $\sqrt{-1}$ . Sir W. R. Hamilton, in the preface to his *Lectures on Quaternions*, p. 41, says, "But I wish to mention that among the circumstances which assisted to prevent me from losing sight of the general subjects, and from wholly abandoning the attempt to turn to some useful account those early speculations of mine, on triplets and on sets, was probably the publication of Prof. De Morgan's first paper on the 'Foundation of Algebra,' of which he sent me a copy in 1841."

As a writer of mathematical text books, he took the highest rank, his books being more suitable, however, for teachers than for pupils. They were characterised by extreme clearness, exhaustiveness, and suggestiveness. Perhaps those best known are his "Elements of Arithmetic," published 1830; his "Elements of Algebra," published 1835; and his "Differential and Integral Calculus, with elementary illustrations," which is a perfect mine of original thought, and in which some of the most important extensions which the subject has since received, are distinctly indicated, and it was published by the Society for the Diffusion of Useful Knowledge.

As an actuary he occupied the first place, though he was not directly associated with any particular office, but his opinion was sought for on all sides, by actuaries, on questions connected with the theory of probabilities as applied to life contingencies. In 1838 he wrote his "Essay on Probabilities," which still retains a high place among the literature of insurance offices.

As a logician he was well known, and his "Formal Logic," together with the Treatise of Mr. Boole, may be said to have created a new era in logical science. His controversy with Sir William Hamilton will long be remembered.

As an historian and biographer, the English *Encyclopædia* says of him that "he had a great affection for, and an extensive and minute erudition in, all kinds of literary history, biography, and antiquities." He was one of the most extensive contributors to the *Penny Cyclopædia*, many of the articles of scientific biography having been written by him, as well as most of the mathematical and astronomical articles. The lives of Newton and Halley in Knight's "British Worthies," were also from his pen.

As a bibliophile, his "Arithmetical Books from the Invention of Printing to the Present Time, 1847," and his "Budget of Paradoxes" will long remain celebrated. He was the possessor of a very large collection of old mathematical works.

In addition to this the Professor contributed largely to the *Philosophical Magazine*, the *North British Review*, the *Athenæum*, and the Transactions of the Cambridge Philosophical Society, in which he published most of his

original investigations. He wrote a "Book of Almanacs," with an Index of Reference, by which the Almanac may be formed for every year up to A.D. 2000, with means of finding the day of the new moon from B.C. 2000 to A.D. 2000. He was also secretary and member of the Council of the Royal Astronomical Society for many years. He and his son, George De Morgan, also a mathematician of great promise, whose untimely death will be remembered, took the most active part in the foundation of the London Mathematical Society, of which he was the first president. Prof. De Morgan will be buried on Thursday, the 23rd, at Kensal Green, but his memory will long be cherished among a large circle of attached and admiring friends.

ARTHUR C. RANVARD

## PAPERS ON IRON AND STEEL

### IV.—THE BESSEMER PROCESS (*continued*).

THE magnificent shower of sparks which accompanies the turning over of the converter is easily explained. The blast has, of course, to be maintained during this turning over, until the whole of the melted material is clear of the openings through which the blast is forced. As these cover a considerable area at the bottom of the converter, the edge of the liquid passes them successively, and at the moment of thus passing the blast cuts the surface of the melted matter almost horizontally. But what is this melted matter? It is a pool of iron, on the top of which is floating a thick scum of silicate of iron, &c.—the "cinder." I use the term "silicate of iron" only in an approximate sense, as I doubt whether the silica is completely oxidised.

My reasons for doubting it are that the particles which are driven out of the converter by the blast are, to some extent, explosive, they are seen to burst with brilliant coruscations which are partly due to further oxidation; and when the granules which shower upon the floor are examined in the microscope, they present a very curious appearance. They are minute hollow spherules, miniature bomb-shells, varying considerably in diameter from one-tenth of an inch to one-fiftieth and less in diameter. The largest are more or less broken, commonly of a basin shape, shown in Figs 1 and 2.\*

The smaller spherules are for the most part perforated. My friend, Mr. Joseph Bragg, who has carefully examined these, and to whom I am indebted for the drawings from which the engravings are copied, says, "I can hardly satisfy myself that any are quite without apertures, though some have no distinct round holes as most have, but in these cases there are minute openings between and under the welded scales or plates which often cover the spherules, giving them a rough surface." Conglomerate groups of these spherules, such as are shown in Figs. 3\* and 4, are very common, and some are attached to irregular lumps of cinder, as shown by the right-hand fragment on Fig. 3. A few are pear-shaped (see Fig. 4). On the right of these pear-shaped specimens are shown some of the smaller spherules in which the perforations are less evident. In the smallest, as the agglomerated and attached specimens (Fig. 3), the perforations are very obscure or doubtful.

Sir Samuel Baker, in his "Nile Tributaries of Abyssinia," describes some natural products due to a similar action on a vastly larger scale, viz., the volcanic eruption of a flood of gaseous matter through fused silicates. He says, "Rows of broken hills, all of volcanic origin, broke the flat plain. Conical tumuli of volcanic slag here and there rose to the height of several hundred feet. We entered a dead level plain of orange-coloured sand, surrounded by pyramidal hills; the surface was strewn with objects resembling cannon shot and grape of all sizes, from a 32-pounder downwards; the spot looked like the old battle-

fields of some infernal region. . . . I dismounted to examine the Satanic bombs and cannon shot. Many of them were as perfectly round as though cast in a mould, others were egg-shaped, and all were hollow. With some difficulty I broke them, and found them to contain a bright red sand; they were, in fact, volcanic bombs that had been formed by the ejection of molten lava to a great height from active volcanoes; these had become globular in falling, and having cooled before they reached the earth, they retained their forms as hard spherical bodies precisely resembling cannon shot. The exterior was brown, and appeared rich in iron. The smaller specimens were the more perfect spheres, as they had cooled quickly, but many of the heavier masses had evidently reached the earth when only half solidified, and had collapsed in falling. The sandy plain was covered with such vestiges of volcanic action, and the infernal bombs lay as imperishable relics of a hailstorm such as may have destroyed Sodom and Gomorrah." To a Lilliputian traveller about an inch and a quarter high the floor of a Bessemer shop would present about the same aspect as this volcanic plain presented to Sir Samuel Baker, and would appear on about the same scale relative to the traveller's own dimensions.

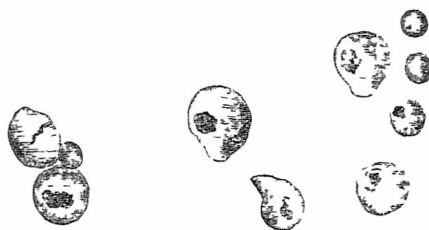


FIG. 4.

It may have been remarked that in the above I have never used the word "slag," which in chemical works is usually applied to the separated silicate of iron, &c., however it may have been separated. I have called it "cinder," in accordance with the nomenclature of the workshop, for in the use of these terms, slag and cinder, the workshop is more learned than the University, even in the matter of etymologies, which occupies so absorbing an amount of University attention.

Whenever the silicate is separated by fusion or the direct action of the fire he calls it "cinder," when it is squeezed out from a bloom or pile by the blows of the hammer he calls it "slag." Now the Scandinavian name of fire refuse or dross is *sinner*, the German for the same is *sinter*. The Scandinavian for a blow is *slag*, the German *schlag*. I have observed with much interest the constancy with which the workman adheres to the strictly etymological signification of these words, while learned writers utterly confound them. Of course the workmen are unacquainted with their origin, nor have I ever seen their distinctive etymologies pointed out by anybody else. They afford an interesting illustration of the technical continuity of modern English with its ancient Scandinavian basis. Our metal workers, like our sailors, still speak the strong tongue of the old Norseman. There are scientific as well as etymological reasons for the distinction between cinder and slag, and therefore I adopt the workmen's phraseology.

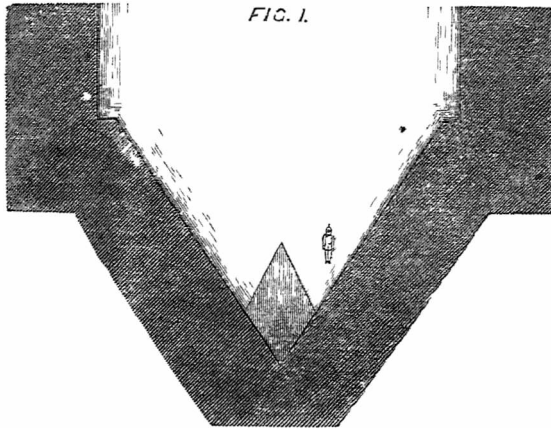
W. MATTIEU WILLIAMS

## SCIENCE IN GOVERNMENT WORKSHOPS

THERE seems to be a singular antagonism between science and officialism. The Government has undertaken more than one special manufacture, and not without a certain measure of success, but even the best of Government factories are tainted with some

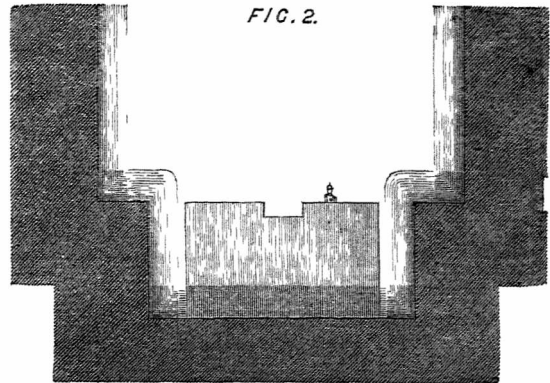
\* Figs 1, 2, and 3 will be found in last week's number of NATURE, p. 389

perverse defiance of scientific principles. Why this should be is too large a question for present discussion, but the fact is beyond doubt. Take, for example, one of the most effective seats of national manufacture—the small-arm factory at Enfield, which is under the command of an officer who may fairly be credited with scientific intelligence. You will see there a considerable amount of what may be called imported science. Outside inventions in machinery, in rifle barrels, in locks, in breech-actions, and other branches of the work,



have been appreciated, adopted, and improved, and this is so far good. The Snider is a very clever makeshift, and perhaps as good a converted rifle as could have been made out of the old Enfield. The projected Henry-Martini, again, has an excellent breech-action, though not quite the best that might have been selected. Its barrel is on a good and tried pattern, although one that has not very successfully competed with the Metford. In these respects, the design cannot be called unscientific, but it is said that one essential element of the new rifle—the sighting—if not absolutely left to be fixed by tradition and routine, will be in principle little better than the worthless sighting of the old Enfield. If a crack shot were offered the choice between a first-rate barrel with clumsy and unscientific sights and an inferior barrel fitted with perfect sights, he would certainly prefer to enter into a competition with the latter weapon. Errors from defective aim are, as a rule, much larger than those due to imperfections of rifling, and to fit a first-rate weapon with bad sights is to throw away nearly all the skill and money which has been expended upon it. This is just what the people at Enfield are doing now, and all for want of familiarity with one of the simplest maxims of geometrical science. When a mathematician, an astronomer, an engineer, or even a superior artisan, wishes to determine with accuracy the position of a point, he almost invariably does it by setting off its distance from each of a pair of rectangular co-ordinate axes. In very special cases and for very special reasons the advanced geometrician will occasionally employ oblique instead of rectangular axes; but whenever it is practicable, whether he is dealing with linear or angular measure, he uses as a matter of course rectangular axes. In a case where he has to measure independent variations in horizontal and vertical directions, he would think it simply absurd to refer the position of a point to any other than a pair of horizontal and vertical axes of co-ordinates. Thus the astronomer has his co-ordinates of azimuth and altitude, of latitude and longitude, the builder works with his plummet and square, and the most simple-minded carpenter, who wished a nail put in a particular spot on a wall, would order it to be driven in at so many feet from the floor, and so many feet from the side of the room. This elementary scientific method has in fact descended to so low a stratum

of intelligent society that most people have assimilated it as if by instinct, and would open their eyes rather widely if they were told that when they practised it they were obeying the dictates of science. And yet, strange as it may seem, this extremely elementary, almost axiomatic, idea of rectangular co-ordinates, has not yet penetrated to the Government factory at Enfield. Consider what the sights of a rifle are for. In the simplest case, when you are aiming at an object the distance of which is known, and when there is no wind, you have nothing to do but to adjust the



sights to the right elevation, and align them upon the object. But if your first shot falls low or high, or if you want to hit another object at a different distance, you must do one of two things, either slide your backsight up or down or else take a fuller or finer sight. In other words, you must correct the error in elevation, either by mechanical adjustment or eye-adjustment in the vertical direction. Practically, large and occasional changes are made by mechanical adjustment; small and frequent changes by eye-adjustment. So again, if there is wind to allow for, you must either give the sights an apparatus for lateral adjustment (which, of course, would be quite inadmissible in a military arm), or, you must make the necessary allowances by eye-adjustment in the horizontal direction. The occasions which require vertical and horizontal corrections are quite independent of each other, the one class being functions mainly of distance, and the other of lateral wind. This is, therefore, precisely the case where the position of the sight should be referred to vertical and horizontal lines.

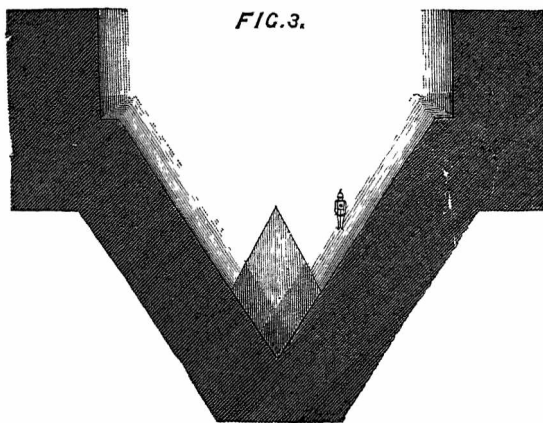
Instead of doing this, our Government manufacturers give you a backsight, bounded by two oblique lines at a certain inclination to the vertical, and they provide you with a foresight, bounded by two other oblique lines at a different inclination to the vertical. When they indulge in a great effort of imagination they sometimes dream of getting rid of the oblique lines on the backsight, still leaving the foresight as bad as ever. Anything more perversely unscientific can scarcely be imagined, though we daresay it will be stoutly defended on the plea that it is the same venerable system which contributed to the non-efficiency of Brown Bess.

To any mechanician, however humble, it must be quite clear that both backsight and foresight ought to be bounded by horizontal and vertical lines. And here we might close the subject but for the stupendous power developed by the military mind, of pooh-poohing suggestions which have only science and reason to recommend them. "Extremely ingenious and scientific, no doubt," our soldier critic may say, "but shows a woeful ignorance of the practical conditions of the problem. You see our recruits are not philosophers, but rough fellows, and we must give them something easy to understand and handle, and capable of bearing rough usage. Experience has shown that there is nothing like the old V backsight and knife-edge foresight, with which the British soldier can go

any where and do anything, &c. &c. You scientific people always forget to look at the practical side of things."

Now that is just what scientific men don't forget. No man can be really practical unless he is also in his measure scientific. But in this matter of sights it may be worth while to follow the advice of our imaginary soldier, and look more minutely at the practical side of the question. What is the test of a good sight? Obviously the best sight is that which enables the rifleman most easily to judge whether two successive aims are alike, or if they differ, to say in what direction and to what extent they do so. For this reason the soldier is taught to discriminate between fine sights, full sights, and half sights, according to the quantity of foresight which he allows to be visible above the bottom of the V. What he sees is an irregular lozenge, and the accuracy of his shooting, so far as elevation is concerned, depends upon his judging with perfect exactness the length of the vertical diagonal of this lozenge. Again, if wind has to be allowed for, he must fix in his mind the apparent distance at which the tip of the foresight should be seen on the right or left of the object. The difficulty of these eye-adjustments is enormously increased by giving him nothing but inclined datum lines from which to estimate. The language in which it is customary at Hythe to inculcate the method of making allowance for wind, curiously illustrates the absurdity of the received sight-pattern. The recruit is told that he must "aim at nothing to hit something," a phrase really very happy as a description of the difficulty of estimating at the same time elevation and lateral allowance with a Government rifle. The most practised shots find it by no means easy to vary their horizontal allowance for wind without in some degree altering their elevation, and all this difficulty is quite gratuitous.

The true test of the value of a system of sighting is of course to be applied rifle in hand, but our pic-



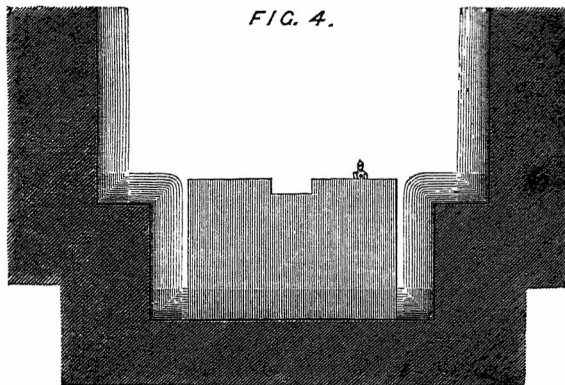
ures will show tolerably well what the result of such a test would be. Figure 1 is what a man sees when he takes an aim with the present military sights. It is meant for a half-sight, the lozenge in the middle being the portion of foresight visible, and the shading being as near a representation as we can give of the haze which always more or less blurs the outline of the backsight. We have supposed a little wind, and the object is therefore seen on one side of the sight, and is as nearly level with the tip of it as it can be brought without the guidance of any horizontal line. Now suppose the rifleman finds that sight correct, and wishes to shoot down a second enemy at the same range and under the same conditions. He will try to take just the same sort of aim again, and Fig. 3 is a pretty good approach to it. Probably the reader will have to look backwards and forwards rather carefully before he can judge whether there is any,

and how much, discrepancy between Figs. 1 and 3, and if (as would be the case in actual practice) Fig. 1 had gone out of existence say only a few minutes before Fig. 3 was looked at, we doubt very much whether the error would be large enough to be discerned at all, and we are sure that its amount would not be correctly estimated.

Now, take the case of rectangular sights such as are drawn in Fig. 2. In this, as in Fig. 1, the elevation is supposed to be normal—that is, with the horizontal top of the foresight level with the top of the backsight below the haze. The allowance for wind is exactly the same as in Fig. 1, and its amount may be fixed in the memory by noting that the object is about twice as far from the outer edge of the foresight as it is from the little rectangular notch which marks the middle of it. Having looked at this, it would be quite possible to go away for a day, and then return and look at Fig. 4, and see at once that this latter differs from the former by being a considerably higher sight with a much larger allowance for wind. No error anything like as gross as this could be made even by the poorest shot in two successive aims. And yet the real differences in elevation and horizontal allowance between Figs. 2 and 4 are not larger than those between Figs. 1 and 3, which cannot be detected or remembered without the greatest difficulty. And this is the result simply of substituting rectangular for oblique sights.

"All very pretty," says our soldier, again, "but how are you to get such a sight as you have drawn, on a rifle meant to carry a bayonet and to be used in war?"

We are fortunately able to answer this question. Figs. 2 and 4 are taken from the actual sights of a rifle prepared as follows—A London armoury rifle of Government pattern was taken; the knife-edge of the foresight was filed clean off, leaving the block, and then a small rectangular groove was filed longitudinally in the middle of the block, thus leaving the foresight less liable to injury than before.



Then the sliding-bar was turned upside down, and a square notch filed instead of the triangular V.

The rifle so altered was rather fitter for rough work than before, and it was possible to aim with it and to make exact allowance for wind into the bargain. The use of it, too, was incomparably easier for a recruit to learn. We may add that the result of actual shooting with it has been quite conclusive in its favour. And yet the beautiful and expensive Henry-Martini is now being turned out with sights which neutralise one half of the accuracy of the weapon by making accuracy of aim impossible.

It will cost at least 1,000,000*l.* to arm our troops with Henry-Martinis in lieu of Sniders, and on a moderate computation one-third of the gain in accuracy (which may be represented by one-third of the cost) is utterly thrown away by the defective sighting.

If these things were not ascertained facts, it would be hard to believe them possible. Is it even yet too late to stop the mischief?

G. W. H.

## NOTES

MR. GEORGE BIDDELL AIRY, Astronomer Royal, has been selected by the Council of the Royal Society as a fit and proper person to be nominated as President of that Society on the occurrence of a vacancy, and Mr. Airy has declared his willingness to accept the proffered honour. As General Sir E. Sabine, the present president, has intimated his intention of resigning office at the next annual meeting, the election, which rests with the fellows, will come on at that time. We may congratulate the Society and English science generally on the wise choice which the Council have made. In scientific distinction, administrative ability, and honesty of purpose, the president-elect will prove no unworthy successor of the distinguished man of science who has now for so many years filled the office.

THE Royal Irish Academy has approved of the following allocations from the fund for promoting scientific researches:—G. J. Stoney, F.R.S., 50*l.*, "For Researches on the interrupted Spectra of Gases;" Prof. R. S. Ball, 6*l.* (additional), "For Experiments on Vortex Rings;" Prof. Henry Hennessy, F.R.S., 20*l.* (additional), "For Experiments on the friction of Fluids in contact with Solids;" Prof. Thiselton Dyer, 29*l.*, "For Researches on Vegetable Physiology;" Prof. Traquair, M.D., 25*l.*, "For Researches on the Crania of Osseous Fishes."

It is stated that the appointment of Professor of Chemistry and Experimental Physics at the Indian Engineering College will be filled up by the transfer of Mr. Herbert M'Leod from the College of Chemistry. We consider this arrangement one which reflects great credit on those who are responsible for it. Mr. M'Leod has long been known not only as an accomplished chemist, but as one who has the rare gift of imparting his knowledge to others, and he has filled the position he held at the College of Chemistry for many years.

WE understand that the names of Dr. Cunningham and Mr. E. Ray Lankester have been selected from the candidates for the vacant Professorship of Natural History in the Queen's College, Belfast, and that it is probable that His Excellency the Lord-Lieutenant will appoint the first named gentleman as successor to Prof. Wyville Thomson.

WE are glad to learn that the "Zoological Research Association," concerning which we some weeks ago inserted a note, is now fully established.

WE regret to have to record the death on the 7th inst., at the age of sixty-eight, of Mr. Henry Denny, the curator of the Leeds Philosophical and Literary Society, an office he had held since 1825. It is to Mr. Denny's untiring zeal and assiduity that the Leeds Museum owes its high position among provincial institutions of a similar character. Unwearied energy, a great knowledge of science, and unfailing courtesy, were combined in him in a manner which will render it very difficult for the society to supply his place. In addition to the title which he held as Associate of the Linnean Society, Mr. Denny was a corresponding member of the Academy of Natural Sciences of Philadelphia and of the Syro-Egyptian Society of London; honorary member of the Philosophical Society of Dickinson College, Carlisle, Pennsylvania; of the Yorkshire Philosophical Society; the Blackmore Museum, Salisbury; and of the Norfolk and Norwich Museum.

THERE are few more zealous cultivators of Astronomy than an Indian gentleman, Mr. Nursing Row, a friend of the late Admiral Manners, who has built an observatory at his own expense at Vezagapatam. Although he has recently suffered a heavy loss of property from a cyclone sweeping over his estate, Mr. Nursing Row sent the munificent donations of 100*l.* to the Mansion House Fund for the relief of the distress in Paris, and

100*l.* to the fund for supplying seed and other aid to the French peasantry. He is also a most generous benefactor to the poor in his own neighbourhood.

WE learn from Paris that the report which reached the Academy of the death of M. Becquerel, the electrician, and which we copied last week, is incorrect. It was his son, M. Dumeril Becquerel, who died during the investment of Paris.

DR. PAGE, of Edinburgh, has commenced a course of thirteen lectures on Geology, descriptive and industrial, in the Mechanics' Institution, Glasgow. The lectures are largely attended by ladies and gentlemen. The study of the science in this large commercial city has received new impetus from the attractive and eloquent manner in which the lecturer presents it. Few, indeed, have the gift which Dr. Page possesses of making scientific study popular. The directors of the Institution are indebted to Dr. Page for enabling them to offer such valuable instruction at so small a charge.

THE Council of the Pharmaceutical Society offers a silver medal for the best herbarium collected in any part of the United Kingdom between May 1, 1871, and June 1, 1872. The collections are to consist of flowering plants and ferns, arranged according to the natural system of De Candolle, or any other natural method in common use. No candidate will be allowed to compete unless he be an associate, registered apprentice, or a student of the Society, or if his age exceeds twenty-one years.

WE have great pleasure in calling attention to the letters which will be found in our columns of correspondence respecting the International College at Isleworth, and the Crawford College at Maidenhead, where instruction in science appears to be given with highly creditable results.

AT the last meeting of the American Academy, a new form of solar eye-piece was exhibited by Prof. Pickering. A cube is made by cementing together two right-angled prisms of glass, which is substituted for the reflector in a diagonal eye-piece. By using a cementing liquid whose index of refraction is very nearly the same as that of the glass, almost all the light and heat pass directly through the cube, enfeebling the image so that it can be borne by the eye with impunity. We can thus cut off as much of the light as we please, and yet avoid all danger of cracking the glass by the heat, as frequently happens when a coloured glass is used to absorb it. Since the relative index of refraction of the inclined surface is very nearly unity, the angle of total polarisation is 45°, or the actual angle of incidence. Accordingly, the image will be perfectly polarised, and may be varied in intensity at will by a Nicol's prism. If we make the angle of incidence equal to 45° in Fresnel's formula, it takes the simple form that the reflected light =  $\frac{\sin 2v}{\cos 2v}$  in which  $v$  is the deviation of

the ray in passing from one medium to the other. In the present case if  $n = 1.01$ , we find that the reflected beam equals 00005, or only one twenty-thousandth part of the intensity of the incident ray, if  $n = 1.001$ , the light is diminished to one two-millionth. On trying the experiment, it was found that the image formed was coloured, the tint changing with the angle of incidence. This curious effect is probably due to the fact that the dispersion of the balsam used for cementing the prisms is greater than that of the glass, and hence the relative index and quantity of light reflected differ for different colours. Apart from its practical application, this instrument possesses a scientific interest as furnishing a means of making large plane surfaces whose index is nearly unity, and thus enabling us to verify laws for whose proof we have heretofore been dependent on observations with gases only.

A SLIGHT shock of earthquake was felt on Friday night in the North of England. In and near Manchester the shock was

felt soon after eleven o'clock. At Singleton Brook, near Manchester, the first shock was felt at precisely six minutes to eleven. A resident says that the windows of his house were violently shaken, as though a heavy vehicle was passing along the road. About five minutes past eleven the noise was again heard, accompanied, as before, by a tremulous motion. This time the effect was much more marked and continuous. At first the impression produced was merely that of trembling, which lasted for perhaps two seconds. This was succeeded by a slight pause of about half a second, and then the beds were distinctly felt to roll from side to side, exactly like the heaving of a ship at anchor, and with the same sharp and sudden check to the motion. The time occupied by the second shock was about four seconds. Immediately before the first shock a heaviness in the atmosphere had been noticed, as if there were a sudden change in the temperature. A similar effect was produced, according to concurrent testimony, in the neighbourhood of Bowdon. A decided shock was experienced at Leeds, and from accounts received from York, Wakefield, Doncaster, and other places, it seems to have been pretty generally felt over the southern part of Yorkshire. The accounts obtained from a variety of sources in Leeds show that it was felt in nearly every part of the borough. The statements vary slightly as to the exact time of the occurrence, but it must have taken place from eleven to a quarter-past. There were two motions, the first being very slight—so slight that no notice would probably have been taken, but for a more decided one which followed, and the result of which was that windows were violently shaken in their frames, and in some houses articles of crockery displaced. At Ulverston and Lancaster the shock was felt. Furniture in houses was thrown over, and people shaken and considerably alarmed. Two distinct shocks were experienced in the neighbourhood of Kendal; the first at about 6.20, the second at about 11.15. The first was not violent, and it does not appear to have been generally noticed, but the second was everywhere felt, and created great alarm. It lasted about ten or twelve seconds, and was felt at a distance of sixteen miles from Kendal, on the borders of Yorkshire. It appears to have taken a south-westerly direction. Several witnesses state that at the time of the occurrence they observed an unusual swell in the waters of Windermere lake. During the evening the atmosphere was very calm and foggy, like that preceding a thunderstorm. At Preston the shock was very keenly felt, and it created very much confusion and alarm. In our Correspondence columns will be found several other letters descriptive of the unusual phenomenon.

M. DECAISNE, director of the *Jardin des Plantes* at Paris, writing to the *Gardener's Chronicle*, thanks the English horticulturists for their offers of assistance, and asks especially for contributions of Pandanaceæ, Nepenthes, Cyclanthes, Orchids, and Ferns. "But," he asks, "who will restore to us the Malpighiaceæ which our illustrious predecessor, Adrien de Jussieu, got together with so much pains? Who can give us back the old plants which were deposited here by such men as Aublet, Commerson, or Du Petit Thouars? For many years our stoves must bear the traces of these cruel losses. The effect," he adds, "of the shells on the monocotyledonous plants was very singular, and different in different cases. Thus the Pandanaceæ, Cyclanthes, and Dracenas had their leaves and young stems completely cut off by the explosions of the shells, while the Bromeliaceæ were uninjured alike by the concussion and by the cold, which destroyed contiguous plants of other families."

WE learn from New Zealand that a fine display of Aurora was seen in that colony on the 24th and 25th of October last. It is not a little remarkable that while on the 24th Lyttleton was almost totally burnt down and the colonial papers attributed the blood-red appearance of the sky to the reflection of the fire,

many persons in this country actually supposed the appearance of our display to arise from the burning of Paris.

ONE of the smartest shocks of earthquake known for some time in New Zealand was felt at Wellington at a few minutes past twelve on the night of the 1st of January last.

THE Marlborough College Natural History Society has issued its report for the half-year ending Christmas 1870, showing that it continues to prosper and to do good work. The most interesting papers printed; at length are one by Mr. F. E. Hulme, "On Mosaic, Ancient, Mediæval, and Modern," containing a history of the art, with a very good illustration; and a prize essay by Mr. J. B. Fuller, "On the Identification of Birds' Eggs;" in which an empirical mode of classification and recognition is given, which will be useful to collectors. As an appendix is printed the commencement of a very careful second edition of a "Flora of Marlborough," by the Rev. T. A. Preston, which is carried on as far as the completion of *Thalamifloræ*.

THE Winchester and Hampshire Scientific and Literary Society has issued its first annual report, a promise, we hope, of good things to come. Although the first meeting was only held in November 1869, under the presidency of the Rev. C. A. Johns, the society now numbers over a hundred members, and seems to have set itself to do useful work in local and general natural history and physical science. Thirteen papers were read before the society during its first session; and a list of plants collected during the year in the immediate neighbourhood of Winchester is promised with the next report. We would remind those who have to compile this list that grasses are flowering plants, although a sentence in the report before us would seem to imply the contrary. The rapid spread of these local natural history societies is a very healthy sign of the increase of the study of science in the country.

THE late numbers of the *Journal of the Scottish Meteorological Society*, of which two, published together, have just appeared, contain, as usual, valuable contributions from Dr. Buchan. In No. 27 he gives his second notice on the Rainfall of Scotland, treating of the central districts from the Firths of Forth and Clyde to the Grampians. The former notice referred to the southern counties. The paper shows that the precipitation in the upper valleys of the Forth and Tay is about 90 inches, or 20 inches more than at the wettest stations in the South. The maximum, 91.90 inches, was observed at Glengyle. It also appears that the amount does not depend on the level of the gauge nearly as much as on local conditions. At Leng, at the height of 325 feet, the amount is 66.37 inches, whereas on Ben Ledi, at the height of 1,800 feet, it is only 58.43 inches. The last number contains a most important paper on the Mean Temperature of these islands, based on the Registrar General's Reports, and on observations from a few foreign stations. The means are taken from the maximum and minimum readings, and in some cases are for thirteen years, in others for less; but all have been reduced to the probable thirteen-year means. Daily range has been disregarded. The paper is illustrated by twelve monthly and a general chart. The results have been carefully discussed by Mr. Buchan, and, whenever possible, with reference to sea temperature. The results for Ireland are of less value than those for Great Britain, owing to the paucity of observations. The paper is specially to be welcomed, as Dove's Tables give but little information for the United Kingdom. The numbers contain some other short papers and the usual tables.

WITH reference to the flowering of the hazel, the *Gardener's Chronicle* calls attention to the singular fact that male catkins often appear in January, which have completely withered away before the female flowers and a second crop of male catkins appears some weeks later, and pertinently asks, what can be the object of this first crop of catkins?

REPORT ON DEEP-SEA RESEARCHES

Carried on during the months of July, August, and September, 1870, in H.M. Surveying Ship "Porcupine." \*

By W. B. CARPENTER, M.D., F.R.S., AND J. GWYN JEFFREYS, F.R.S.

(Continued from p. 334.)

DIRECTING our course again towards the Algerine coast, we kept nearly parallel to it during the greater part of the next day, occasionally sweeping the bottom with the "tangles," which gave us abundance of Polyzoa, Echinoderms, &c., of well-known types, without any specimens of novel or peculiar interest. We reached Algiers on the afternoon of the 26th; and as it was necessary to take in coal, we remained in harbour until the 29th, when we resumed our easterly course, still keeping near the coast. The weather now began to be oppressively hot; the surface-temperature of the sea rising to 76° or 78°, and that of the air being often several degrees higher. Wishing to see what would be the point at which the effect of this extreme superheating would cease to manifest itself, we took a set of serial soundings at Station 53, with the following result, which we incline to consider typical of the condition of the proper surface-water of the Mediterranean in the summer season:—

	° Fahr.
Surface . . . . .	77
5 Fathoms . . . . .	76
10 " . . . . .	71
20 " . . . . .	61.5
30 " . . . . .	60
40 " . . . . .	57.3
50 " . . . . .	56.7
100 " . . . . .	55.5

Thus the amount of heat lost in the first 20 fathoms is no less than 15°.5; and as much as 9°.5 of this loss shows itself between 10 and 20 fathoms.

Again proceeding into deep water, we perseveringly explored the bottom with the dredge; and from a bottom of 1,508 fathoms we brought up some hundredweights of the same barren mud as had previously given so much trouble to so little profit. The sieve and the washing-tub again returned for answer "barren all." Disappointing as this negative result was to us as zoologists, there are aspects under which it may be viewed that may give it no small value to geologists. On these, however, we can more fittingly enlarge hereafter. Once more, shifting our ground a few miles, we put down our dredge in 1,456 fathoms, and brought it up loaded with a similar profitless freight.

We now determined to keep closer to the shore, and worked for several days along the African coast, for the most part using the "tangles," the ground being too rocky for the dredge. Here we came upon a small fleet of coral fishers, and were not a little interested in finding that they employed "tangles" similar to our own as their most effective method of collecting. We swept the shore with these very assiduously, usually between 50 and 100 fathoms; and although we obtained Polyzoa, Echinoderms, and corals in considerable abundance, there were not many of special interest. We may note, however, that several of the Polyzoa which occurred in the region in which the red coral is found had, when fresh, a red colour nearly as brilliant as that by which it is characterised; but this colour, in the Polyzoa, was quite evanescent.

The extreme heat of the weather having produced an exhausting effect upon our crew, especially on the engineers and stokers, Capt. Calver considered it desirable to give them rest; and we accordingly made for the Bay of Tunis, which we reached at mid-day on Saturday, Sept. 3rd. The town itself is situated at the head of a shallow lagoon, or salt-lake, that communicates with the sea by a narrow channel, and at this entrance there is a small sea-port named the Goletta, having a basin for vessels of moderate size. The lake, although about six miles long, has only from six to seven feet of water at its deepest part; and when the water is unusually low, a small steamer, which plies between the Goletta and Tunis, is not always able to run, as happened at the time of our visit. Owing to the great evaporation, and the absence of any stream of fresh water, the water of this lake is usually very salt; but when heavy rains fall the level is considerably raised, and the saltiness is diminished. Thus the condition of this lake in regard to that of the sea outside is sometimes that of

the Mediterranean in regard to that of the Atlantic, and sometimes that of the Baltic towards the German Ocean; and we would suggest whether it might not be possible, through our Consulate (which has an office at the Goletta), to have a regular series of observations made upon the relative densities of the water of the lake and that of the sea, and upon the direction of the upper and under current in the channel of communication between them, that might furnish valuable data for the complete elucidation of the subject of currents occasioned by excess of evaporation. We availed ourselves of this short rest to visit the town of Tunis, which, for the most part, retains its genuine Moorish character; and the ruins of Carthage, a few miles off, the most remarkable part of which consists of a series of immense reservoirs for water, supplied by an aqueduct that brought it from a range of mountains at no great distance, from which also the modern town of Tunis is supplied.

This part of our work having brought us to the neighbourhood of the Island of Pantellaria, we landed on it with the view of visiting, if possible, a cavern which had the reputation of being "of icy coldness." As we found, however, that a whole day's delay would be involved, we gave up the idea; and we afterwards obtained elsewhere the information we desired. The continuance of the very hot weather having brought a large part of our crew to a state of such exhaustion as to render a continuance of our operations undesirable, Captain Calver considered it expedient to proceed to Malta without further delay; and we anchored in the Harbour of Valetta on the morning of Saturday, September 10. Here we found it necessary to remain for ten days, the illness of our chief engineer, which we at first hoped might be only temporary, proving sufficiently serious to require that a substitute should be found for him. Our time was passed very pleasantly in visits to the various objects of interest in which the island abounds, and in the enjoyment of the kind hospitality of His Excellency the Governor, Vice-Admiral Key, and other officers. The time was too short for any careful examination of the geology of the island; but one point which struck me as of special interest in relation to the deposit at present forming on the Mediterranean bottom will be specially noticed hereafter.

Quitting Valetta Harbour at midday on September 20, we steered in a N.E. direction towards a point about sixty miles distant, at which a depth of 1,700 fathoms was marked on the chart. This we reached early the next morning (60); and a sounding being taken, 1,743 fathoms of line ran out. As this was the greatest depth we had anywhere met with in the Mediterranean, and as the basin in which the sounding was taken is cut off by the shallows between Sicily and Tunis from all but superficial communication with the western basin, we watched the heaving-in of the sounding apparatus and its accompaniments with no little interest. The thermometers recorded a temperature of 56°, which was one degree higher than that which we had met with in our two deepest soundings (1,456 and 1,508 fathoms) in the western basin. The sample of the bottom brought up in the tube of the sounding apparatus indicated the prevalence of a yellowish clayey deposit so similar to that which had elsewhere proved so disappointing, that we could not feel justified in pressing Capt. Calver for the sacrifice of nearly a whole day, which would have been required for a single cast of the dredge at this depth. The specimen of bottom-water brought up by our water-bottle surprised us by its very small excess of density above the surface-water; the specific gravity of the former being only 1.0283, whilst that of the latter was 1.0281; and the proportion of chlorine per 1,000 being 21.08 in the former, whilst that of the latter was 20.77. The surface-water being here more dense than the average, the bottom-water was less dense; a result which a good deal surprised us at the time, but which subsequent comparison with the densities of specimens taken from the greatest depths we had sounded in the western basin showed to be by no means exceptional. And when we came to reason out the mode in which surface-evaporation may be presumed to operate in augmenting the density of the water beneath, we found it to be quite in accordance with a priori probability, that the deepest water should show the least excess of density above the water at its surface.

Having thus satisfied ourselves, so far as we could do by a single set of observations, that the physical conditions which we had found to prevail in the western basin of the Mediterranean present themselves also in the eastern, we steered for the coast of Sicily; and in a few hours came in sight of Syracuse, with the lofty mass of Etna as a magnificent background in the remote distance. The clouds which lay upon its summit during the earlier part of the day gradually

\* Extracted from the Proceedings of the Royal Society.

dispersed as we approached it, so that we could distinctly trace the outline of its cone, save where this was obscured by a constantly shifting semi-transparent cloud. Whether this was a light smoke given off from the cone, or a film of vapour condensed by the contact of a current of warm moist air with the colder surface of the mountain-summit, we were unable to distinguish, though we watched it with great interest during the whole afternoon. We steamed quietly along the Sicilian coast during the night, so that sunrise the next morning found us in the narrowest part of the Strait of Messina, between Messina and Reggio; and we shall not easily forget the beauty of the spectacle we then beheld on either shore. Passing through the once-dreaded Charybdis, the dangers of which are rather poetical than real, and leaving on our right the picturesque castle-crowned rock of Scylla, we passed out of the "Faro," which narrows at its northernmost extremity to about three and half miles, into the open sea to the north of Sicily, studded by the Lipari Isles; and steered direct for Stromboli, stopping at 10 A.M. to take a sounding (station 61). This gave us a depth of 392 fathoms, and a bottom temperature of  $55^{\circ}7$ , which afforded no indication of unusual elevation. Here again we found the density of the bottom-water scarcely in excess of that of the surface-water; and it was even lower than the surface-water in another sounding taken somewhat further on, (station 62), and at a depth of 730 fathoms, which gave a bottom temperature of  $55^{\circ}3$ .

	Sp. Gr.	Chlorine.
Surface . . . . .	1.0281	21.32
Bottom, 392 fathoms . . . . .	1.0282	21.36
Bottom, 730 fathoms . . . . .	1.0280	21.22

This result, again, surprised us much at the time; but we are now inclined to attribute it to the decrease of surface-evaporation, consequent upon the marked decrease in the heating-power of the sun, which showed itself in the change of the relative temperatures of the sea and air. For whilst for some days before we put into Malta, the surface-temperature of the sea had ranged between  $76^{\circ}$  and  $78^{\circ}$ , and the temperature of the air had been usually about  $1^{\circ}$  higher, we now found that while the surface-temperature of the sea ranged between  $73^{\circ}6$  and  $76^{\circ}6$ , the temperature of the air was between  $2^{\circ}$  and  $4^{\circ}$  lower. This difference continued to show itself nearly all the way to Gibraltar; the daily averages of the surface-temperature of the sea ranging between  $73^{\circ}1$  and  $75^{\circ}6$ , whilst those of the temperature of the air ranged between  $68^{\circ}5$  and  $72^{\circ}0$ . We now approached the rugged cone of Stromboli, from the summit of which there was constantly issuing—as has been the case since the time when the neighbouring island of Hieria was fabled to be the workshop of Vulcan—a cloud of smoke, indicative of active changes in the molten depths beneath. Of this activity, however, we had found no special indication in the temperature-soundings taken nearest to the island. Whether the general prevalence in the neighbourhood of Sicily of a bottom-temperature averaging about a degree above that of the western part of the Mediterranean, is due to subterranean heat, is a question which can only be determined by a larger number of observations than we had the opportunity of making. As we neared Stromboli, we were much struck with the height to which the energetic industry of its inhabitants had carried the vine-cultivation all round the cone, save on two slopes looking N.W. and S.E., over one or other of which there is a continual discharge of volcanic dust and ashes. Although no flames were visible during daylight, we could distinctly perceive occasional flashes as night came on. Our course was now laid straight for Cape de Gat, which we passed on the 27th of September, arriving at Gibraltar on the evening of the 28th. The only scientific observations which we had the opportunity of making during this part of our voyage were confirmatory of those which we had made at the commencement of our Mediterranean cruise as to the lower temperature and inferior density of the surface-water, both which we attribute to the inflow from the Atlantic.

Having taken in at Gibraltar as much coal as we could carry, we left the harbour at 9 A.M. on the 30th September, and proceeded at once towards the scene of our previous observations. We thought it worth while, however, to take a sounding in our way towards this, near the 100-fathom line (station 63), for the sake of ascertaining the temperature and specific gravity of the bottom-water. The depth was found to be 181 fathoms, showing that the slope from the shallow to the deep portion of the channel is here very rapid. The bottom-temperature was  $54^{\circ}7$ , that of the surface being  $68^{\circ}$ ; and the specific gravity of the

bottom-water was 1.0280, that of the surface being 1.0271. This bottom-water thus agreed closely in both particulars with that of the deep mid-channel, as ascertained in our first set of observations, and confirmed by our second.

We then steamed out to a point (station 64) nearly identical with that from which our previous investigations had been carried on; and commenced our work with a temperature-sounding. The surface-temperature ( $65^{\circ}6$ ) proved to be here less by  $2^{\circ}4$  than it had been found to be at station 63; and this although it was taken an hour later in the forenoon, when an increase might have been expected. It thus corresponded closely with what had been previously found to be the average temperature of the Strait in mid-channel, both during the first approach at Gibraltar from westwards, and during our own experiments at the commencement of the Mediterranean Cruise; and the continuation of the like observations during the remainder of the day and ensuing night gave the same remarkable result, the rationale of which will be considered hereafter. The depth was somewhat less than at the neighbouring station 39, being 460 fathoms instead of 517; but the bottom temperature was a little lower, being  $54^{\circ}7$  instead of  $55^{\circ}5$ . The respective specific gravities of the surface and bottom waters, and of that of the intermediate stratum of 250 fathoms, were found to coincide almost exactly with those previously determined, as the following comparative statement shows:—

	Sp. Gr. Station 39	Sp. Gr. Station 64
Surface . . . . .	1.027.1	1.027.1
250 fathoms . . . . .	1.029.3	1.029.2
Bottom . . . . .	1.028.1	1.028.3

Now the density of the bottom-water here corresponds so exactly with that which prevails over the deeper bottom of the western basin of the Mediterranean, whilst it so considerably exceeds that of the bottom as well as of the surface water of the Atlantic, that we cannot fail to recognise it as belonging to the Mediterranean basin; so that, if it has any motion at all, we should expect that motion to be from east to west. Still more certainly may this be affirmed of the intermediate stratum, the density of which corresponds with that of the bottom waters of the shallower part of the Mediterranean basin; the greatest depth (586 fathoms) at which such water was obtained, being at station 40, the nearest point to the Strait from which a specimen of bottom water was obtained. And it may be further predicated that a stratum of water of a density of 1.029.3 could not overlie water of the density of 1.028.1, unless it moved over the stratum below, that is, unless (1) the two strata were moving in opposite directions, or (2) were moving at different rates in the same direction, or (3) the upper stratum were in motion in either direction, and the lower stratum were stationary. It will presently appear that the second of these conditions is the one which obtains in the present case.

We now proceeded to repeat our experiments with the "current-drag," with the view of obtaining, if possible, unequivocal evidence of the existence of that westerly under-current, which so many considerations combined to render probable. The direction of the wind during this set of experiments was from the east, or opposite to that of the surface-current; and its force (3 to 4) was sufficient, by its meeting the current, to produce a considerable swell, which necessitated the employment of a larger boat, and rendered it unsafe to allow her to drift without men. The sectional area of the boat was therefore greater than on the former occasion, giving the in-current a stronger hold upon her; but, on the other hand, the surface she presented to the wind was also greater; and as this acted in the opposite direction, the latter increase might be considered to neutralise the former, or even rather to exceed it, so as to render the boat more capable of being carried westwards by the "current drag," if this should be acted on by an outward under-current. The rate of surface-current was tested as before, and proved to be 1.823 mile per hour, its direction being N.E. by E.  $\frac{1}{2}$  E. This was a retardation of more than a mile per hour as compared with the former observation; and that it was not attributable to the mere surface-action of the easterly wind, was clear from the result of the next observation, which showed that the retardation extended to a depth far below the influence of surface-action.—The "current-drag" having been lowered to 100 fathoms' depth, the drift of the boat was reduced to 0.857 mile per hour, or less than half its surface-drift; its direction was nearly the same as that of the surface-current, viz., E. by N.  $\frac{1}{2}$  N. The "current-drag" was then lowered to



a depth of 250 fathoms; and in a short time the boat was seen to be carried along by it in a direction (W.N.W.) almost exactly opposite to that of the middle in-current of the Strait. The rate of outward movement of the boat was 0.400 mile per hour; but from the considerations formerly stated, it is clear that the actual rate of the under-current must have exceeded that of the boat on the surface. The "current-drag" was then lowered down to a depth of 400 fathoms; and again the boat was carried along in nearly the same direction as in the previous experiments, namely N.W.  $\frac{1}{2}$  N.; but more slowly, its rate of movement being 0.300 mile per hour.

Thus, then, our previous deductions were now justified by a *conclusive proof* that there was at this time a return-current in the mid-channel of this narrowest part of the Strait, from the Mediterranean towards the Atlantic, flowing beneath the constant surface-stream from the Atlantic into the Mediterranean; and it will be shown hereafter, by a comparison of all the results of our observations, that a strong presumption may be fairly raised for the constant existence of such a return-current, though its force and amount are liable to variation.

As the determination of the boundaries of this return-current, and of the amount and conditions of its variation, could

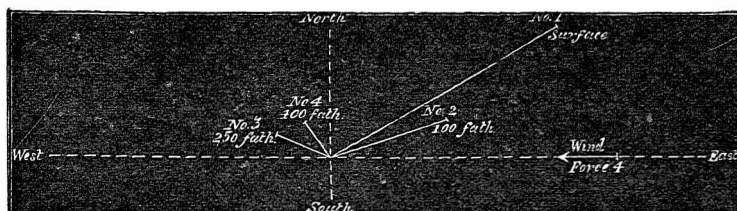


FIG. 1.—Rate (per hour) and Direction of Movement of Surface-Float, and of Current-Drag at different Depths; with Force and Direction of Wind.

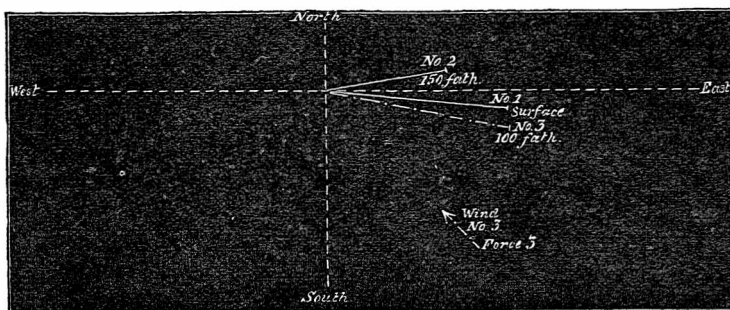


FIG. 2.—Rate (per hour) and Direction of Movement of Surface-Float, and of Current-Drag at different Depths; with Force and Direction of Wind in No. 3. (No Wind in Nos 1, 2.)

only be effected by multiplied simultaneous observations at different points, with ample license as to time, neither of which fell within the scope of the present expedition, we were obliged to content ourselves, as regards this locality, with what we had found ourselves able to accomplish; and at the conclusion of this day's work we proceeded westwards under easy steam, so as to be able to resume our experiments the next morning in the shallowest part of the Strait.

The average surface-temperature of the mid-stream during our outward passage through the Strait proved to be 66°; thus corresponding exactly with what we had found it to be on our inward passage seven weeks previously. This depression, as compared with the surface-temperature of the Strait itself nearer the shore, both north and south, and with the temperature of the Mediterranean to the eastward and that of the Atlantic to the westward, is extremely remarkable. We shall hereafter inquire how it is to be explained.

The breadth of the Channel between Capes Spartel and Trafalgar is about twenty-three nautical or twenty-six and a half statute miles. Its northern half is much shallower than the southern, the 100-fathom line off the Spanish coast running at about twelve miles' distance from Cape Trafalgar; whilst along the African coast it keeps much nearer the shore, being at only two miles' distance from Cape Spartel. Between these two lines, the greatest depth marked in the chart is 194 fathoms; and this occurs off Cape Spartel, at less than a mile from the 100-fathom line. Between this and the opposite border of the deeper channel, the depths vary from 130 to 180 fathoms; the abruptness of the differences at neighbouring points indicating a rocky bottom, of which we soon had unpleasant experience.

### SCIENTIFIC SERIALS

IN the *Journal of Botany* for March we find a continuation of the useful catalogue of new species of Phanerogamous plants published in Great Britain during the year 1870, and of Mr. Hiern's paper on the forms and distribution over the world of the *Batrachian* section of *Ranunculus*. Dr. Dickie contributes a paper on the distribution of Algæ, and Mr. A. G. More the commencement of a Supplement to Bromfield's "Flora Vercensis." Short notes, reviews, and reports of Societies fill up the number.

THE *American Naturalist* for February contains several interesting papers. Among them is one on the ant-lion (*Myrmeleo immaculatus*), a Neuropterous insect, by Mr. J. H. Emerton, with drawings of its matamorphoses; one on the resources and climate of California, by Rev. A. P. Peabody; notes on some birds in the Museum of Vassar College, by Prof. Jas. Orton; a short account of the spores of Lichens, by Mr. H. Willey; the Sperm Whales, giant and pigmy, by Dr. Theodore Gill, illustrated with numerous drawings, including the skull of *Callignathus simus* and *Physeter macrocephalus*. The Natural History Miscellany comprises also several shorter papers of much interest, including one on the morphology and ancestry of the King Crab, by the editor, Dr. A. S. Packard, jun.

THE March number of the *Geological Magazine* (No. 81) commences with a long article by Mr. James Croll "On the Determination of the Mean Thickness of the Sedimentary Rocks of the Globe." The author discusses the different methods which have been adopted in order to obtain an approximate estimate of the time occupied in the formation of the sedimentary rocks, and remarks that in all these researches it must be borne

in mind that, from the continual action of denudation, the existing sedimentary rocks only represent a fraction of the whole thickness of sediments that have been deposited. Taking the denudation of the area of the Mississippi as a guide, he estimates the wearing down of the land at one foot in 6,000 years, and the matter thus removed spread over the bottom of the ocean would produce a deposit one foot thick in 14,400 years. Taking the maximum thickness of British sedimentary strata as calculated by Prof. Ramsay, namely, 72,000 feet, to represent the mean thickness of all the sedimentary rocks which ever have been formed, the author thus gets 1,036,800,000 years as the age of the stratified rocks. Mr. Croll also notices the conditions of the deposition of the sediment carried from the land, and his remarks upon this subject are all worthy of consideration. The editor, Mr. H. Woodward, describes and figures a new Myriopod from the Scotch coal-measures, under the name of *Euphoberia Brownii*, and also some new palæozoic Phyllopod Crustacea, namely *Ceratiocaris ludensis*, a gigantic species from the Lower Ludlow of Leintwardine, *C. oretensis* and *C. truncatus*, from the yellow carboniferous limestone of Oreton and Farlow in Worcestershire, and *Dithyrocaris Belli*, from the Middle Devonian of Gaspé. He also figures a specimen of *D. tenuistriatus*, McCoy. Mr. De Rance communicates a paper on the occurrence of two distinct glaciations in the Lake District; Mr. John Aitken notices some curious faults occurring in drift at Stockport in Cheshire; and Mr. S. C. Perceval describes the occurrence of Websterite at Brighton.

## SOCIETIES AND ACADEMIES

### LONDON

Royal Society, March 16.—“Description of *Ceratodus*, a genus of Ganoid Fishes recently discovered in rivers of Queensland, Australia.” By Dr. Albert Günther, F.R.S. We shall return to this communication.—“On the Formation of some of the Subaxial Arches in Man.” By George W. Callender.

Geological Society, March 8.—Mr. Joseph Prestwich, F.R.S., president, in the chair. Lieut. Lewis de Teissier Prevost and Mr. John Haines were elected Fellows of the Society; and Dr. C. Nilsson, was elected a foreign member of the Society. The following communication was read:—(1) “On the Red Rocks of England of older date than the Trias,” by Prof. A. C. Ramsay, LL.D., F.R.S., V.P.G.S. The author stated that the red colour of the Triassic beds is due to peroxide of iron, which encrusts the sedimentary grains as a thin pellicle. This could not have been deposited in an open sea, but rather in an inland salt lake or lakes. The peroxide of iron, which stains the Permian, Old Red Sandstone and Cambrian rocks, is believed by the author to have been deposited in the same manner, in inland waters, salt or fresh. Agreeing with Mr. Godwin-Austen, the Old Red Sandstone was of Lacustrine origin. The absence of marine shells helps to this conclusion. The fish do not contradict it, for some of their nearest living congeners live in African and American rivers. The life of the Upper Silurian deposits of Wales and the adjoining districts continued in full force up to the passage-beds, which mark the change from Silurian to Old Red Sandstone. In these transition strata, genera, species, and individuals are often few, and dwarfed in form. Near Ludlow and May Hill the uppermost Silurian strata contain seeds and fragments of land plants, indicating the neighbourhood of land, and the poverty of numbers and the small size of the shells a change in the condition of the waters. The fish of the Old Red Sandstone also indicate a change of condition of a geographical kind. The circumstances which mark the passage of Silurian into Old Red Sandstone were as follows:—First, shallowing of the sea, so that the area changed into fresh and brackish lagoons, afterwards converted into great freshwater lakes. At the present day marine species are occasionally found living in fresh water, as for example in the Swedish lakes. The same may have been the case in the Old Red Sandstone period. The Old Red Sandstone waters at their beginning are comparable to the Black Sea, now steadily freshening; or the Caspian, once united to the North Sea, if by a change of amount of rainfall and evaporation it freshened by degrees, and finally became a freshwater lake. The Permian strata, to a great extent, consist of red sandstones and marls in the greater part of England; and the Magnesian Limestone of the north of England is also in less

degree associated with red marls. These do not occur in the same districts of England, excepting in Lancashire, where a few beds of Magnesian Limestone are interstratified with the marls. The sandstones and marls being red, the colouring matter is considered to be due to peroxide of iron, possibly precipitated from carbonate of iron, introduced in solution into the waters. Land plants are found in some of the Permian beds, showing the neighbourhood of land. No mollusca are found in most of the red beds, except a brachiopod in Warwickshire, and a few other genera in Lancashire, in marls associated with thin bands of Magnesian Limestone. The traces of amphibians are like those found in the Keuper Sandstone, viz., *Dasyceps Bucklandi* and labyrinthodont footprints in the Vale of Eden and at Corncockle Moor, printed on damp surfaces, dried in the sun, and afterwards flooded in a way common in salt lakes. Pseudomorphous crystals of salt and gypsum help to this conclusion. The molluscos fauna of Lancashire, small in number, in this respect resembles the fauna of the Caspian Sea. The fauna of the Magnesian Limestone of the east of England is more numerous, comprising thirty-five genera and seventy-six species, but wonderfully restricted when compared with the Carboniferous fauna. The specimens are generally dwarfed in aspect, and in their poverty may be compared to the Caspian fauna of the present day. Some of the fish of the Marl-Slate have strong affinities to carboniferous genera, which may be supposed to have lived in shallow lagoons, bordered by peaty flats; and the reptiles lately described by Messrs. Howse and Hancock have terrestrial affinities. Besides the poorness of the Mollusca, the Magnesian Limestone seems to afford other hints that it was deposited in an inland salt lake subject to evaporation. Gypsum is common in the interstratified marls. In the open sea limestone is only formed by organic agency, for lime, in solution, only exists in small quantities in such a bulk of water; but in the inland salt lakes carbonates of lime and magnesia might have been deposited simultaneously by concentration of solutions due to evaporation. Some of the Magnesian Limestone strata have almost a tufaceous or stalagmitic aspect, as if deposited from solution. The Cambrian strata also show some evidence of not being true marine deposits. They are purple and red, like the other strata previously spoken of; and the surfaces of the beds sometimes exhibit sun-cracks and rain-pittings. The trilobite *Palaopyge Ramsayi* is considered by the author to be an accidental marking, simulating the form of a trilobite; and the fossils of St. David's are found in grey beds, which may mark occasional influxes of the sea, due to oscillations of level. The foregoing reasonings, in the author's opinion, lead to the conclusion that a continental area existed more or less in the northern hemisphere from the close of the Silurian to the end of the Triassic epoch, and that this geographical continuity of land implies probable continuity of continental genera. There is therefore no palæontological reason why the *Hyperodapedon*, *Telerpeton*, and *Stagonolepis* of the Elgin country should be considered of Triassic age, especially as the beds in which they occur are stratigraphically inseparable from the Old Red Sandstone. Finally, terrestrial and marine European epochs were rapidly reviewed. 1. The Cambrian epoch was probably fresh water. 2. The Old Red Sandstone, Carboniferous, Permian, and Trias were formed during one long continental epoch. This was brought to an end by partial submergence during the Jurassic epoch; and by degrees a new continental area arose, drained by the great continental rivers of the Purbeck and Wealden series, as shown in various parts of Europe. 3. This continent was almost entirely swallowed up in the Upper Cretaceous seas. 4. By subsequent elevation the Eocene lands were formed, and with this continent there came in a new terrestrial fauna. Most of the northern half of Europe since then has been continental, and its terrestrial fauna essentially of modern type. If according to ordinary methods we were to classify the old terrestrial faunas of North America, Europe, Asia, and probably of Africa, a Palæozoic epoch would extend from Old Red Sandstone to Wealden times, and a Neozoic epoch at least from the Eocene period to the present day. The Upper Cretaceous strata would at present remain unclassified. The marine epoch would also temporarily be divided into two, Palæozoic from Laurentian to the close of the Permian times, and all besides down to the present day, would form a Neozoic series. The generic gaps between the two begin already to be filled up. The terrestrial and the marine series at their edges at present overlap each other. The great life-gaps between the two terrestrial periods may some day be filled up by the discovery of the traces of old continents containing intermediate developments of structure as yet undiscovered. Prof. Huxley was pleased to find that

the author, on physical grounds, extended some views which he himself had, from other reasons, brought before the Society. He mentioned that there had lately been found in the freshwaters of Australia a remarkable fish, which had been described, he thought erroneously, as a *Ceratodus*, but which, in many essential characters, was a *Dipterus*, though allied in some respects to *Phaneropleuron*. In other respects it was connected with *Lepidosiren*. It was about to be described by Dr. Günther. The dentition of this fish is curiously similar to that of the Devonian *Dipterus*; and its existence, he thought, corroborated Prof. Ramsay's argument. He agreed with the author as to his views respecting the terrestrial fauna of ancient times, and was quite prepared for the discovery of mammalian remains in earlier formations than those in which they are at present known. He did not so cordially agree with his views as to the marine fauna. He would carry back the forms from which those of the present day are immediately derived to Cretaceous rather than Eocene times. Between the Cretaceous and the Liassic strata there was what appeared to be a middle group, succeeding the Palæozoic. Mr. Etheridge commented on the dwarfed condition of our Permian fauna, which corresponds in the main with that of the Continent, though with fewer genera and species. Prof. Rupert Jones protested against some of the reasons adduced for regarding some of the areas cited as having been inland lakes, though no doubt such lakes must have existed. He thought that mere colour could not be taken as a criterion. If it were, he inquired why the bottoms of the present lakes were not red? Many of the red rocks were, moreover, full of marine fossils. He contended for the true trilobite character of *Palæopyge Ramsayi*, and mentioned its occurrence and that of *Lingula ferruginea* in red Cambrian rocks as proving the marine character of the beds. The Magnesian Limestone he also insisted upon as a purely marine and open sea deposit. Prof. Morris thought the subject required further consideration before the whole of Prof. Ramsay's views were accepted. The Cambrian beds, for instance, containing great beds of conglomerate, seemed such as could only be due to marine action, and would derive their red colour from the decomposition of the old hornblende gneiss from which they were derived. With regard to the Red Sandstone, he would inquire whether the colour might not be derived from the decomposition of rocks composed of hornblende materials. The Old Red Sandstone beds, though in this country containing fishes which might be of freshwater genera, had in Russia the same fishes associated with marine shells; and much the same was the case in the Trias. Dr. Carpenter had been led to the conclusion that wherever there was an inland sea connected with the ocean by a strait even of moderate depth, there was a double current tending to preserve some degree of similarity between the waters of the two, the difference of specific gravity in the Mediterranean as compared with the Atlantic being about as 1.026 to 1.029. In the Red Sea, where so little fresh water came in, and there was an evaporation of nearly eight feet per annum, the water was but little saltier than that of the ocean with which it was connected. In the Baltic there is an undercurrent inwards, which still keeps it brackish; for otherwise the influx of fresh water was so enormously in excess of the evaporation, that it would long ago have become perfectly fresh. Such facts bore materially on the speculations of the author. Capt. Spratt maintained that in the Dardanelles there was not a trace of such an undercurrent as mentioned by Dr. Carpenter. In the winter months, when the flow of the rivers into the Black Sea was for the most part arrested by ice, the salt water of the Mediterranean was carried into the inland seas, and these being much deeper than the channel of the Dardanelles, the salt water, by its greater specific gravity, remained in the bottom of the sea of Marmora, so that while the upper portion of the water and that on the shores were fresh, marine conditions existed in the deep centre of the sea. Dr. Duncan mentioned that in certain coral reefs intersected by freshwater currents, the corals still continued to be formed; so that the existence of dwarfed forms of corals in ancient times was quite consistent with modern facts. Mr. Forbes commented on the chemical features of Prof. Ramsay's view, and could see no reason why the beds containing iron should not have been deposited in the open sea. Many beds, for instance the Gault, contain more iron than those which are now red, though they may be grey or blue. In sands the grains are often coloured only superficially with iron, probably derived from sulphates. In other cases the sands consist of fragments of rocks already red. There was, in fact, no reason why the beds

deposited in the open sea might not subsequently, by oxidation, become perfectly red. Prof. Ramsay replied to the remarks of the various speakers, and summed up by contrasting the usual colour of marine fossiliferous beds with that of the thick, almost non-fossiliferous rocks of which he had been treating.

Anthropological Institute, March 20.—Sir John Lubbock, Bart., M.P., president, in the chair. Mr. William Sloan and Mr. John Edward Brearey, of Madras, were elected members. After the adjourned discussion of Mr. Jackson's paper, "The Racial Aspect of the Franco-Prussian War," Mr. Hyde Clarke read a paper "On the Migrations of the Georgians, Circassians, and Amazons, and their connection with the Tibeto-Caucasian race," of which the following is an abstract:—By means of the application of the Georgian, Circassian, and other existing languages *in situ*, the existence of a previous Georgian or Caucasian population was shown, and that the extent of its area was much greater than could have been suspected. This Palæogeorgian language had a much nearer relation to the existing languages than the Hieroglyphic to the Coptic, or the Cuneiform to the Syriac and Persian, but it was in a different and earlier stage of comparative grammar than the Hebrew or Sanskrit, and to which the Caffre group presents some resemblances of structure. The connection of the language with the comparative mythology of the worship of fire and water, gives further evidence as to the diffusion of a population which had held empire over India and thence to the Atlantic shores and these islands. Accepting as a doctrine the conquest of Palestine from the Canaanites and other races identified with the Caucaso-Tibetans, the period of empire would range from 3,500 to 4,500 years ago, during which the germs of the existing civilisation were developed. This population belonged to the family which includes the Tibetan and Chinese stocks. Many portions of the Mosaic record, considered to have been interpolated during the Babylonian captivity, now appeared to be of the greatest antiquity. Many subjects, corollary to the main discoveries, were touched upon, including the connection of the Etruscan, the Phrygian, the languages of Asia Minor, the Akkaa with the Palæogeorgian, also the Lydo-Assyrian rock-cut monuments, the Cyclopean buildings, the so-called Druidic structures, the discovery of metals, &c.

Royal Geographical Society, March 13.—Major-General Sir Henry C. Rawlinson, K.C.B., vice-president, in the chair. The following new Fellows were elected:—Sir James Anderson; W. Blackmore; R. B. Jackson, Sir Donald F. McLeod, K.C.S.I., C.B.; Capt. James Nicol; G. Wm. Petter. The paper read was, "On Mr. Baines's Explorations of the Gold-Fields of South Africa," by Dr. R. J. Mann, and was founded on the voluminous journals, itineraries, astronomical observations, &c., sent home by Mr. Thomas Baines, who had been employed, since the end of 1868, in making a general survey of the gold-yielding country lying between the Limpopo and Zambesi rivers. Leaving the Limpopo at its north-western bend, near the Makloutse and Shapsa rivers, he traversed, with his companions, the range of highlands separating the basins of the Zambesi and Limpopo, in a north-easterly direction, for 300 miles, negotiating with the powerful Matabele chiefs, fixing geographical positions, investigating the mineralogy, and sketching, with his well-known artistic skill, the scenery and people. His farthest point to the north was 17° 30' S. lat., and in one part of his route he was within 120 miles of the Zambesi. On the route, the heads of a great number of streams were struck, flowing on the one side into the Zambesi, and on the other towards the Limpopo or Indian Ocean, the high land (averaging about 3000 feet) forming the watershed in this part of Africa. The country was healthy, but rather barren and arid, especially on the western slope of the watershed. The chief of the Matabele came to an amicable agreement regarding the working of the gold, which was found very widely distributed over the region, but only in quartz reefs, not in alluvial washing. Many additional particulars regarding the country were given, after the reading of the paper, by Sir John Swinburne, who travelled over most of the same ground, and partly in company with Baines. He said the dry uplands were totally unfit for European settlement, but the well-watered northern and eastern slopes were fertile, and adapted for all kinds of tropical produce. The rich, well-wooded country on the eastern side, rugged with precipitous hills and deep valleys, was inhabited by a superior negro tribe, called *Mashonas*, totally distinct from the invading Matabele of the opposite (western) side of the uplands. Whilst the Matabele—a section of Caffres—follow no arts but those of war, and go nearly

naked, the Mashonas are well clothed, and practise the art of smelting and working iron in great perfection. He exhibited a specimen of gold, weighing 27 ounces, extracted by his men from the quartz reefs. Mr. Galton spoke of the great additions made by Mr. Baines, in this journey, to our topographical knowledge of Africa; and Mr. Dunlop stated that quartz had now been found in the country yielding eight and ten ounces of gold to the ton, and that the country was a suitable field for British enterprise.

Linnean Society, March 16.—Mr. G. Bentham, president, in the chair. Col. Grant was elected a fellow.—Prof. Oliver exhibited specimens of *Cupania cinerea*, Poepp. belonging to the order Sapindaceæ, from the Kew Herbarium, in which the seed, partially surrounded by an arillus, splits open, and the exalbuminous embryo falls out, leaving the testa and arillus on the tree, the only instance known of such dehiscence of the seed itself.—An extract was read from a letter from General Munro to Dr. Hooker, describing the vegetation of a little known part of the island of St. Vincent, in the West Indies.—Mr. Henry Reeks exhibited a series of forms of *Aspidium* from Woodhay in Hampshire, which he considered showed a regular gradation between *A. aculeatum* and *A. angulare* of authors.—Notes on *Capparis galeata* and *C. Murrayi*, by Mr. N. A. Dalzell, who believes that these two perfectly distinct species have generally been confounded with one another.—Dr. B. Seemann exhibited a lamellicorn beetle from Nicaragua, one of the largest Coleoptera yet found in America.

PARIS

Academy of Sciences, March 13.—A sharp discussion arose on reading the *procès verbal* of the last sitting. General Morin complained that it was stated by M. Sainte Claire Deville that science had not received proper application in warfare. He was obliged to confess that the French artillery was not up to the times, since they had no steel guns. Steel guns had been condemned as useless by the committee because His Majesty was a great artilleryist.—The report of the death of M. Becquerel, sen., during the investment of Paris was stated to be incorrect. It was really M. Dumeril, the son of the celebrated electrician, who had died; M. Becquerel, sen., was not present at the sitting.—M. Leverrier was present at the sitting. M. Dumas read for the learned astronomer a long memoir on the Defence of the Rhone Valley, to which M. Leverrier was attached during the investment of Paris. He resided at Nîmes and not at Marseilles, as had been said. The principal feature of this work is the construction of an apparatus for optical signalling. This apparatus can be used during day-time, and signals can be seen at a distance of eight miles by day with the naked eye.—M. Serret, President of the Scientific Delegated Commission at Tours and then at Bordeaux, read over a reclamation on behalf of M. Bouccarut, who claims a right to the invention of the instrument manufactured by M. Janssen for guiding aëronauts. M. Serret gave a certificate testifying that M. Bouccarut in the month of September communicated an instrument similar to M. Janssen's compass. If so why did the Delegated Scientific Commission keep the communication without warning the Government of National Defence at Paris, where the instrument was much wanted, as not less than ten balloons were lost, five of them in the sea, because aëronauts were unable to see their way? M. Delaunay read a declaration stating that he acknowledged that Mr. Hennessy had used the same arguments as himself against Mr. Hopkins' theory relative to the fluidity of the interior parts of the earth. But the adhesion given by Sir W. Thomson and other learned men to Mr. Hopkins' views is the reason why he did not regret having again raised this much controverted question.—M. de Fonvielle presented a paper explaining why the gas inside an aërostat very often suddenly increases in density. The phenomenon is common in warm weather when the gas is saturated with vapour from the water of the gasometer, and also when the balloon is rising at a quick rate. The increased density is owing to a quick refrigeration corresponding to the dilatation of the gas when the balloon is ascending to a higher level. It is an illustration of the law of equivalence of *force* and *heat*. It is the same experiment as is noted in Tyndall's special treatise on that subject, when damp air is placed under an air-pump worked at a certain rate. The movements of the balloon being able to be controlled, it is possible, through an aëronautical ascent, to come to a numerical conclusion.—M. Bouley delivered an interesting lecture on the cattle plague, which is one of the most important topics of the moment. He gave conclusive evidence

that it was imported by the Prussian armies. The plague has had really terrific effects in the provinces. On a sea coast the carcasses of infected animals were so numerous that it was impossible to bury them. The authorities were obliged to fill with the putrid cargo old hulks, which were sunk by cannon balls from a distance. He said that infected animals were not unwholesome in their flesh. A secret committee was opened on the question, proposed by M. Sainte Claire Deville.

DIARY

THURSDAY, MARCH 23.

ROYAL SOCIETY, at 8.30.—Experiments on the Successive Polarisation of Light, with the Description of a New Polarising Apparatus: Sir Charles Wheatstone, F.R.S.—On an Approximately Decennial Variation of the Temperature at the Observatory Cape of Good Hope, viewed in connection with the Variation of the Solar Spots: E. J. Stone, F.R.S.  
SOCIETY OF ANTIQUARIES, at 8.30.—On Flint Implements and other Antiquities from Kent: J. Brent, F.S.A.—On Miscellaneous Antiquities from Leicestershire: Rev. Assheton Pownall, F.S.A.  
ROYAL INSTITUTION, at 3.—Davy's Discoveries: Dr. Odling.  
LONDON INSTITUTION, at 7.30.—On the Colonial Question: Prof. J. E. Thorold Rogers, M.A.

FRIDAY, MARCH 24.

QUEKETT MICROSCOPICAL CLUB, at 8.  
ROYAL INSTITUTION, at 9.—Colour: Prof. Clerk Maxwell.  
ROYAL COLLEGE OF SURGEONS, at 4.—On the Teeth of Mammalia: Prof. Flower.

SATURDAY, MARCH 25.

ROYAL INSTITUTION, at 3.—Spirit of the Age: Mr. O'Neil.  
ROYAL SCHOOL OF MINES, at 8.—Geology: Dr. Cobbold.

MONDAY, MARCH 27.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.  
INSTITUTE OF ACTUARIES, at 7.—On the Equitable Appointment of a Fund between the Life-tenant and the Reversioner: Andrew Baden.  
LONDON INSTITUTION, at 4.—On Astronomy: R. A. Proctor. (Educational Course.)  
ROYAL COLLEGE OF SURGEONS, at 4.—On the Teeth of Mammalia: Prof. Flower.

TUESDAY, MARCH 28.

ROYAL INSTITUTION, at 3.—Nutrition of Animals: Dr. M. Foster.

WEDNESDAY, MARCH 29.

SOCIETY OF ARTS, at 8.—On Woman's Work, with Special Reference to Industrial Employments: Miss Emily Faithfull.  
ROYAL COLLEGE OF SURGEONS, at 4.—On the Teeth of Mammalia: Prof. Flower.

THURSDAY, MARCH 30.

ROYAL SOCIETY, at 8.30.  
SOCIETY OF ANTIQUARIES, at 8.30.  
ROYAL INSTITUTION, at 3.—Davy's Discoveries: Dr. Odling.  
LONDON INSTITUTION, 7.30.—On Economic Botany: Prof. Bentley.  
CHEMICAL SOCIETY, at 8.—Anniversary Meeting.

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