THURSDAY, MAY 29, 1884

THE DILUTION OF DOG POISON

M. PASTEUR has communicated to the French Academy of Sciences (May 19, 1884) the results of his experiments on the attenuation of the virus of rabies, which, if they should be confirmed, would furnish us with the means of protecting dogs from rabies, and as a necessary sequel of protecting the human race from hydrophobia, that absolutely deadly and intractable disease which in every country where rabies exists devours every year some hundreds of human victims.

Starting from the idea, now well established for at least some of the infectious maladies, viz. that the virus of a particular disease of this class on its passage through different species of animals is subject to alteration of its virulence, M. Pasteur inoculated monkeys with the virus taken from a dog affected with rabies, and found that it thereby became considerably altered. This alteration consists in a decrease of intensity, and it is the more marked the greater the number of removes. After the third remove (*i.e.* after having passed successively through three monkeys) it becomes attenuated to such a degree that inoculation with it of dogs, rabbits, and guinea-pigs does not produce fatal rabies. Dogs so inoculated remain protected against further virulent poison such as is derived from a rabid dog.

But on the other hand the virus of rabies on its passage through the rabbit and guinea-pig increases in virulence, its intensity becoming even greater than that of the virus taken from a dog, rabid in the usual way (*rage des rues*). The maximum increase in intensity is not, however, attained until several transmissions through the rabbit or guinea-pig.

In this way it is possible to produce virus of various degrees of intensity, from the weakest, *i.e.* virus taken from the rabid dog and passed successively through several monkeys, to the strongest, *i.e.* virus passed successively through several rabbits or guinea-pigs.

M. Pasteur states that he has succeeded, by inoculation of the blood of rabid animals, in devising a simple method of obtaining attenuation of the virus, and of herewith protecting dogs from fatal rabies, but the experiments not being yet completed do not permit of a detailed description.

Without wishing to say anything derogatory as regards these remarkable results, it is greatly to be regretted that M. Pasteur, not being himself a pathologist, has not availed himself of the aid of his medical colleagues, in order to definitely ascertain whether the disease which he produced by inoculation in the dog, monkey, rabbit, and guinea-pig—for this seems to be at the root of his statements—was really rabies. However, he has asked and obtained from the French Minister of Public Instruction a Commission which is to compare the results of the inoculation, from a rabid dog, of twenty dogs, previously treated by M. Pasteur with his attenuated virus, with those of the inoculation of twenty other dogs not previously "vaccinated."

This Commission, comprising such acknowledged authorities in physiology and pathology as M. Béclard, M. Paul Bert, M. Bouley, Dr. Villemin, and Dr. Vulpian, will no doubt soon be able to decide this question one way or the other, and its judgment will be awaited by all medical men as well as by the general public with anything but indifference.

The experiments of M. Pasteur, published in the *Comptes Rendus* of the Academy of Sciences for May 19, are these :—

I. "If rabies is transmitted from the dog to the monkey, and further, from monkey to monkey, the virulence of the virus becomes weakened on each transmission. The virus, having become diminished in virulence by these transmissions from monkey to monkey, if reintroduced into the dog, rabbit, or guinea-pig, maintains its attenuated character. In other words, the virulence does not return at a bound to the virulence of the virus of a dog affected with rabies of the usual kind, *i.e.* produced by the bite of a dog (*à rage des rues*).

"Under these conditions the attenuation can easily be accomplished by a small number of transmissions from monkey to monkey, to such a point that it does not produce rabies in the dog by hypodermic inoculation. Even inoculation by trephining, an infallible method to communicate rabies, cannot produce any result; it creates nevertheless a refractory condition of the animal against rabies.

II. "The virulence of the rabid virus increases on its passage from rabbit to rabbit, and from guinea-pig to guinea-pig. When in this way the virulence has reached its maximum in the rabbit, it can be transmitted in this state to the dog, and it shows here a much greater intensity than the virus obtained from a dog affected with rabies in the usual manner (*rage des rues*). This virulence is of such an intensity that after inoculation into the blood of a dog it invariably produces fatal rabies.

III. "Although the virulence increases on the passage of the virus from rabbit to rabbit, or from guinea-pig to guinea-pig, it requires several successive transmissions through these animals to attain its maximum, having previously become attenuated by its passage through the monkey. Similarly the virulence of the ordinary rabies of the dog, which, as we have just shown, is not by any means the greatest that the rabid virus is capable of attaining, requires several successive transmissions through the rabbit in order to attain its maximum.

"It follows from the experiments just described that we can easily render dogs proof against rabies. It is readily understood that the experimenter can at will procure rabid virus attenuated in various degrees: some, non-fatal, protecting the animal from the effect of more active as well as of fatal virus.

"The following example illustrates this :—Extract by trephining from a rabbit dead of rabies after an incubation prolonged by several days beyond the shortest period of incubation in the rabbit. This latter is generally comprised within seven to eight days after inoculation, by trephining, with the most intensive virus. From the above rabbit, *i.e.* the one with the prolonged incubation, virus is taken and inoculated, always by trephining, into a second rabbit; from this again virus is taken and inoculated into a third rabbit. Each of these different samples of virus, increasing in strength on every transmission, is at the same time inoculated into a dog. This latter will then be found capable of resisting the most fatal virus, having become completely refractory to rabies, no matter whether the virus, derived from a case of common rabies (*rage des rues*), is introduced by intravenous inoculation or by trephining."

THE MAMMALIA OF INDIA AND CEYLON

Natural History of the Mammalia of India and Ceylon. By Robert A. Sterndale, F.R.G.S., F.Z.S. (Calcutta: Thacker, Spink, and Co.; London: Thacker and Co., 1884.)

THIS book may fairly be described as an attempt by an unscientific writer to compile a scientific work. The author is favourably known as a describer of Indian wild sports, and his observations on the habits of animals are generally good and often original. His best known publication, "Seonee or Camp Life in the Satpura Range," although not quite equal to Forsyth's delightful "Highlands of Central India," rises above the level of ordinary Indian sporting works. In the volume now published he has attempted the somewhat ambitious task of compiling a popular manual of Indian mammalia, comprising not only those described in Jerdon's "Mammals of India" (which is restricted to the kinds found in the Indian Peninsula and the Himalayas), but also the species living in Assam, Burmah, Ceylon, and "the countries bordering the British Indian Empire on the north." By including some (not all) of the mammals described by A. Milne-Edwards from Eastern Tibet, several of those recorded by various authors from Kashgaria, Afghanistan, and Persia, and some Malay types, the total number of species enumerated is brought up to 482. This number, however, is partly made up by nominal species, the writer having compiled his lists from various authorities of unequal value.

Had Mr. Sterndale confined his descriptions to the larger and better known mammals of India and the surrounding countries, he might possibly have achieved greater success. He has bestowed much labour upon the book, and has in some cases, but unfortunately not in all, had recourse to good and recent information. Thus he adopts Flower's and Mivart's classification of the *Carnivora*, and Alston's arrangement of the rodents, whilst he places the dugong in the *Cetacea*, and *Galeopithecus* amongst the lemurs.

The actual descriptions of species are for the most part taken from other writers, and the same may be said of localities, which, however, are not always correct, even in the case of the larger and better known animals. Thus the markhor (*Capra falconeri* v. *megaceros*) is said to be found in Ladakh, where it does not occur, although common in Astor and Gilgit, and the hog-deer, *Axis porcinus*, is stated to exist "throughout India, though scarce in the central parts," whereas it is not known with certainty to inhabit any part of the peninsula of India except the plains of the Ganges and Indus. Many other instances might be quoted. Mr. Sterndale is not even aware that *Tragulus kanchil* exists in Tenasserim, although its occurrence there was well known to Blyth, at least twenty-five years ago. He is unaware also that *Canis lupus* has been obtained in Gilgit, and *Nectogale elegans* in Sikkim. But although *Tragulus kanchil* does not receive a number and separate notice as one of the Indian mammalia, *Mustela nudipes*, a purely Malay insular type, not recorded from continental Asia, is included in the list as No. 190, with the remark that "this species may be discovered in Tenasserim." There is a want of system in the admission and exclusion of species throughout. Thus *Macacus thibetanus* (No. 23) and *Nemorhædus edwardsii* (No. 453) are described, whilst *Semnopithecus roxellana*, *Elaphodus cephalophus*, and *Cervulus lachrymans* are ignored, although all are from the same country in Eastern Tibet, and described in the same work by one author. Similarly whilst some Andaman and Nicobar bats, *e.g.* *Rhinolophus andamanensis* (No. 48) and *Phyllorhina nicobarensis* (No. 63) are included, no mention is made of four *Megacheiroptera* from the same islands, viz. *Pteropus nicobaricus*, *Cynopterus brachyotus*, *C. scherzeri*, and *C. brachysoma.*

As might be anticipated, the micro-mammalia are not treated in a manner that will afford much aid to a student. The writer is unacquainted with Mr. Oldfield Thomas's important paper on the rats and mice, and with Mr. Dobson's work on the *Insectivora*. The account of the latter order and of the *Rodentia* is full of errors. The mistakes in the case of the bats are even less excusable, for Dobson's catalogue is quoted, and, to some extent, followed. Had Mr. Sterndale simply taken all his names, descriptions, and localities from Dobson he would have been safe. But he appears to have found a difficulty in making the names and the arrangement in Jerdon's "Mammals" fit into Dobson's scheme, and he has adopted a compromise, with the result that, besides repeating several mistakes of Jerdon's, he has added not a few of his own. Thus, to take a few examples, he gives as two distinct species No. 54, *Hipposideros armiger*, and No. 64, *Phyllorhina armigera*, although he notices that *Hipposideros* and *Phyllorhina* are the same genus. He quotes as distinct species No. 92, *Scotophilus fuliginosus*, and No. 119, *Miniopterus schreibersii*, shown by Dobson to be identical. Similarly No. 58, *Hipposideros larvatus*, is the same as No. 59, *H. vulgaris*. But perhaps the most characteristic instance of error is in the last species in the order No. 121, *Nyctophilus geoffroyi*. This is taken from Jerdon, and no trace of it is said to be found "in Dobson's monograph, which is so exhaustive as far as Asiatic species are concerned." As the bat in question (*N. timoriensis*) is peculiar to the Australian region, it is naturally omitted in Dobson's "Monograph of Asiatic *Chiroptera*," but it is included in his General (British Museum) "Catalogue of Chiroptera." Jerdon's mistake in classing the species as Indian was founded on what looks very like a printer's error in Blyth's "Catalogue of Mammalia in the Museum of the Asiatic Society."

These details will show the character of the work: mistakes such as those enumerated are to be found throughout. At least a dozen omissions have been noted besides those already mentioned. The book is well printed and illustrated, and many details of osteology, &c., described and figured, so that it is important to show why, despite its merits, it falls far short of what is required in an exhaustive account of Indian mammalia.

There are two portions of the work of which it is possible to speak in terms of high praise. First, wherever the habits of animals are recorded on personal observation they have evidently been accurately and carefully noted. The author is a genuine naturalist with a thorough love and admiration for animals, and in consequence he possesses considerable power of understanding and appreciating them. Secondly, the woodcuts are numerous and for the most part excellent. A few, such as the big-headed Gaur (*Bos gaurus*) on p. 530 and the musk-deer on p. 493 are less successful, and it may be questioned whether a nylgao can stretch itself into the gallop depicted at p. 477, but the spirit of the cut last-named would atone for a worse fault, and there is far more ground for admiration than for criticism. As an amusing work, with good illustrations, to which residents in India may have recourse for the identification of the principal mammals, this volume will probably find a ready place in the Anglo-Indian library. For the determination of the smaller kinds, and for a knowledge of the less known and more difficult species, the student will do well to search elsewhere.

W. T. B.

NORTH AMERICAN MOLLUSCA

A Review of the Non-Marine Fossil Mollusca of North America. By Charles A. White. (Washington: Government Printing Office, 1883.)

THE Hon. J. W. Powell, the Director of the Geological Survey in the United States, continues his valuable contributions to scientific knowledge by the publication of his annual reports; and the volume which is now before us forms part of the Report for 1881-82.

This volume contains 144 pages, besides a full index, and thirty-two lithographic plates. It is carefully and modestly written, and the author candidly admits that our knowledge of the subject treated by him is "very imperfect." The title of the work may be open to a slight criticism; and the word "inland" ("*binnen*" in German) might be preferable to the negative expression "non-marine," which is used by the author.

The geological formations which are embraced in the "Review" are the Devonian, Carboniferous, Jurassic, Triassic, Cretaceous, Laramie, and Tertiary. With respect to the Laramie formation, the author regards the group as occupying a transitional position between the Cretaceous and Tertiary; it is remarkably fossiliferous, inasmuch as a greater number of the species mentioned in the "Review" come from that group than from any other. The total number of North American non-marine or inland fossil species and well-marked varieties appears to be 227, of which 141 are found in the Laramie formation or group. Twelve species are Palæozoic, and of these no fewer than seven species belong to the Pulmonibranchiata, and to the families *Limacidæ* and *Helicidæ*, which are not only terrestrial mollusca, but undoubtedly air-breathers. *Strophites grandæva* of Dawson, from the Devonian formation, is by far the most ancient land shell hitherto known to us. In the face of these facts and in the absence of any facts to warrant the conclusion of the author, how can we reasonably agree with him "that molluscan life began in the sea, and that all fresh-water and land mollusca have been primarily derived from those of marine origin"? Although no land mollusk has yet been discovered in the oldest fossiliferous formation, it is evident that land and consequently terrestrial conditions must then and long previously have existed, so as to account for the sedimentary strata of which that formation consisted and for the prevalence of *Lingula* and other shallow-water Brachiopoda in the Silurian epoch.

It is curious to notice that so many species of what are usually considered marine Conchifera (*Ostrea*, *Anomia*, and *Mytilus*) occur in the Laramie group, and one of *Anomia* in the Cretaceous formation. This confirms the experiments of Beudant and other naturalists, that many marine gill-bearing mollusks can live either in their own native and proper element or can gradually become accustomed to a brackish and ultimately a fresh-water habitat. The author also notes the "persistence through long periods of geological time of even the simpler types of non-marine mollusks, after they were once established." And he remarks with respect to the Gastropoda that, "although in geological rank the Gasteropoda are so much in advance of the Conchifera, the various families of the former seem to have been developed as early in geological time as those of the latter, and so far as we are now acquainted with the history of the fossil non-marine mollusca of North America, it appears that highly-organised land pulmonate Gasteropods were introduced quite as early as any of the Conchifers. Indeed from present indications we are led to believe that the relations of the different classes of non-marine mollusca to each other were much the same in all geological epochs as they are to-day." The following is also interesting:—"Notwithstanding the annual migration of myriads of aquatic birds between the northern and southern provinces of North America at the present time, and doubtless also ever since it has been a continent, the fresh-water molluscan fauna of those regions respectively are still distinct."

A few minor points of classification which are met with in the present work will not be accepted by conchologists without some hesitation, *e.g.* the extension of the so-called family *Rissoidæ* (or more properly *Littorinidæ*) so as to include the genera *Hydrobia* and *Bythinella*, which latter is a subgenus of *Bythinia* and belongs to the *Paludinidæ*. The families *Pisidiidæ*, *Physidæ*, *Ancylidæ*, *Vitrinidæ*, *Arionidæ*, *Pupidæ*, *Succinidæ*, and *Viviparidæ* seem to be also superfluous. In every well-organised army there ought to be a due proportion of men to officers of different ranks.

J. GWYN JEFFREYS

OUR BOOK SHELF

Plant-Life. By Edward Step. Third Edition. (London: T. Fisher Unwin, 1884.)

THIS is another attempt to give a popular description of some of the more sensational parts of the science of botany; though the plan is disconnected, the general idea of the book would not be bad, provided it were well carried out. It is to be regretted that the author has failed to realise that it is necessary to be accurate in popular description. For instance, it is gravely stated in italics that roots are never green (p. 29); we also read that *Ruscus aculeatus* "presents the remarkable appearance of a flower growing in the centre of a leaf" (p. 94), that the Cryptogams have no embryo (p. 211), and that the *Ricciaceæ* and *Characeæ* have stomata (p. 212)! On p. 171 he mistakes intercellular spaces for cells in *Isoëtes*, which he classes under the *Marsiliaceæ* (spelt *Marcileaceæ*, p. 212); and on p. 165 we are informed that the elaters of *Equisetum* are composed of cells. As is usual in works such as this, the terminology of the reproductive organs of the lower forms is very erratic: thus he uses the terms "spore" and "antheridium" as equivalent in *Selaginella* (p. 139), he calls the "sporogonia" of the Mosses "sporangia," and the "oogonia" of *Fucus* "perispores."

On the subject of the lichen-gonidia theory he waxes warm, stating (p. 150) that it has been "termed sensational romance by every well-known practical fungologist and lichenologist." Of course every one is free to express his own opinion, but few who are not blind partisans will be prepared to agree with Mr. Step in excluding such men as De Bary, Schwendener, and Stahl from the list of "well-known practical fungologists and algologists."

Till so-called popular books are written with more accuracy, we should strongly advise those who wish to dabble in science either to abstain, or, better, to brace their minds to attack some text-book which can be depended upon: after this, if they wish, they can easily supply for themselves that cheap sentiment with which "Plant-Life" abounds.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Equatorial Coudé of the Paris Observatory

It was only on the 7th of this month that my attention was called to a letter in NATURE (p. 4) from M. Lœwy, headed "Reply to Mr. Grubb's Criticisms on the Equatorial *Coudé* of the Paris Observatory." I deferred answering this letter as I was travelling at the time, and had not the necessary data by me to refer to; further, because I desired to see the second part of M. Lœwy's letter before making my reply; and lastly, because I hoped that some of the errors in M. Lœwy's first letter were misprints, and that he would have corrected them in his second.

I may observe in passing that the paper to which M. Lœwy alludes is a description of an instrument in the construction of which I am at present engaged, and that any criticisms of the equatorial *coudé* which it contained were merely incidental.

M. Lœwy assumes that my instrument is a modification of one which he described in 1871 in the *Comptes Rendus*. This description I have, as it happens, never seen, nor am I much concerned to defend myself from the suggestion of plagiarism, since the fundamental principle of what I have called the "siderostatic telescope" is one the advantages of which were recognised long before 1871, although mechanical difficulties prevented its application.

I find some difficulty in rendering my reply intelligible to your readers, for although the equatorial *coudé* has been described and figured in NATURE, they are not as yet familiar with the form of the instrument which I am at present constructing. I now proceed to consider M. Lœwy's first letter.

I cannot admit that M. Lœwy's recital of what he is pleased to call my criticisms is accurate. He says:—

"To give weight to his argument Mr. Grubb examines a case of the construction of an instrument of 27 inches aperture, and he anticipates in the construction the following difficulties which he considers insurmountable:—(1) The optical difficulty of constructing a large plane mirror. (2) The practical difficulty of procuring a disk of the necessary dimensions. Mr. Grubb affirms there is no glass-works capable of making a disk of glass so large. (3) The difficulty of moving a mirror of which the weight, according to Mr. Grubb's calculations, will be very nearly half a ton. (4) The dearness of the instrument, which would cost more than an ordinary equatorial plus dome and observatory."

With regard to (1) I may remind M. Lœwy that I distinctly admitted the "*possibility*" of constructing such a mirror, but I expressed the opinion that inasmuch as no mirror of this size had yet been attempted success was problematical.

I now learn from M. Lœwy that such a mirror has been made, and that it "leaves absolutely nothing to be desired"; but he has not told us to what tests this mirror has been subjected. I am not aware that there exists in Paris an object-glass of sufficient size to embrace the whole pencil of light reflected from it, and without this it is not possible, in my opinion, to apply tests which can be legitimately considered final.

(2) I did say that *I believed* it to be impossible to obtain disks of such large dimensions, and I founded my belief on the fact that not many years ago I applied to several of the principal glass manufacturers of England, France, and Germany for prices of disks for mirrors, the weight of which would have been less than those mentioned by M. Lœwy, and none were willing to undertake the work. I am glad, however, to learn from M. Lœwy that the glass manufacturers are now prepared to furnish disks of such a size.

(3) The next difficulty M. Lœwy attributes to me is "the difficulty of moving a mirror of which the weight, according to Mr. Grubb's calculations, will be very nearly half a ton," and this, he says, "*has arisen from some error in calculation.*"

I would ask M. Lœwy to point out where I said anything of the difficulty of moving a mirror of half a ton weight. As I had a considerable share in the construction of the Melbourne mirrors, which weighed nearly four times this, it is hardly likely that I would assert such an absurdity; and as to the allegation of a wrong calculation, I ask M. Lœwy to point out the mistake he refers to, and in order to give him every facility for so doing I append it below. It is necessary first, however, to settle the matter of thickness.

M. Lœwy, in NATURE, May 1 (p. 5), says:—"I have never said that the thickness should be 0·18 of the diameter. I have given 0·18 as a *maximum*."

I have, however, before me a paper presented by M. Lœwy to the Academy of Sciences, March 19, 1883, in which occurs the following passage:—"Mes recherches m'ont démontré que pour prévenir dans un miroir toute déformation causée par la flexion ou un léger *serrage*, il faut que l'épaisseur du verre soit de 0·18 du diamètre." Now if I understand this rightly, it means that he has found 0·18 of the diameter to be the *minimum* thickness necessary, and in no part of that paper does he speak of 0·18 as a *maximum*. He mentions in the following paragraph that a thickness of one-fourth is necessary under certain conditions; and further on in the same paper he says:—"C'est dans ces conditions que les miroirs du nouvel instrument ont été construits." This being so, I still think I was justified in assuming 0·225, a mean between one-fifth and one-fourth, as that which he recommended. Now as to diameter. He assumes a diameter of 38 inches to be sufficient for a 27-inch objective, but $27 \times \sqrt{2} = 38{\cdot}178$. Even this would only give full aperture of objective for the central pencil. For a moderate field nearly $38\frac{1}{2}$ would be in actual use.

Again, no optician in practice thinks of making a mirror without some margin; in small sizes one-fourth to one-half of an inch, but in such a size as this three-fourths of an inch all round is not an extravagant allowance, and therefore in adopting 40 inches diameter I did not exaggerate.

I therefore had as my data—

Diameter 40 inches.
Thickness $40 \times 0{\cdot}225 = 9$ inches.

The calculation then is simple.

$$\text{Solid contents in cubic feet} = \frac{\text{Area of 40 inch circle} \times 9}{1728} = 6{\cdot}547 \text{ cubic feet};$$

and, taking a specific gravity of 2·5, each cubic foot would weigh $156\frac{1}{4}$ lbs.; therefore the weight of mirror $= 6{\cdot}547 \times 156{\cdot}25 =$ 1023 lbs., or *rather more than 9 cwt.* I said nearly half a ton.

I may add that the specific gravity of the glass supplied to me by Messrs. Chance is rather more, viz. 2·52, which would give a higher result.

In another place M. Lœwy represents me as finding that "the mirror necessary for an equatorial *coudé* of 27 inches would weigh $8\frac{1}{2}$ tons"!!

I never made such a statement, and I challenge M. Lœwy to say what grounds he has for this assertion.

This is the second case in which he attributes to me statements which I have not made. A third and a fourth we shall come to just now. Your readers will remark that M. Lœwy (except in one minor instance) never quotes my words. Hence perhaps have arisen the serious mistakes into which he has fallen. Respecting the matter of thickness, M. Lœwy appears to have altered his opinion since he presented his paper on March 19, 1883, to the Academy of Sciences; but, as I have shown, *he did make the statement he now repudiates;* and even if the result of my calculations, founded upon that statement, do not agree with what he now considers to be necessary, he has no right to attribute the discrepancy to any error of mine.

M. Lœwy then proceeds to show that it *is* possible to attach a weight of three-quarters of a ton to end of cross tube. This, I need hardly say, I never disputed; what I did say was, "The absurdity of hanging this three-quarters of a ton" (*i.e.* weight of mirror, objective, and all their supports and attachments) "on end of cross tube, *and yet calling the instrument one of precision*, is too apparent to need demonstration." If I were asked if it would be possible to hang three-quarters of a ton on each end of the Greenwich transit, I might be able to reply in the affirmative, but if I were asked to guarantee that the instrument would, under its new conditions, be as perfect an instrument of precision as it is in its present state, I would not be inclined to risk my "*reputation*" by any such guarantee, and yet M. Lœwy compares the equatorial *coudé* to a transit instrument in stability.

Lastly, on the question of expense. M. Lœwy is anxious to know where I obtained my information, but as I am content to accept his own figures (see his letter in your issue of May 1), so far as the equatorial *coudé* is concerned, there is no occasion to discuss this point. I take the 12-inch size, as it is the nearest to the only one completed, and most likely to be accurate. A 12-inch equatorial *coudé* is estimated at 44,000 francs, *i.e.* say 1760*l.*

Now, in estimating the relative costs of the two forms, your readers will agree with me that for our purposes the fair comparison is between the equatorial *coudé* and such equatorials as are most generally in use in this country, and it is well known that for 1760*l.* a first-rate 12-inch equatorial and dome can be procured, and *this is as nearly as possible what I said*, and I have to thank M. Lœwy for furnishing me with materials to prove my case with so little trouble.

My paper at the Royal Dublin Society (so far as concerned the equatorial *coudé*) was mainly confined to showing that in consequence of its complication it presented many difficulties in its manufacture, particularly for large sizes, and I considered (as I do still consider) that too much was sacrificed in endeavouring to make it an instrument of precision, and to obtain universality. The very fact of its being difficult to construct renders any success the more creditable, and I gladly take this opportunity of expressing my admiration for the excellence of the optical work of the Messrs. Henri, which appears to have withstood the enormous strain put upon it by the peculiarity of construction of the instrument. I still consider, and in this opinion I am joined by the several astronomers of eminence to whom I have spoken on the subject, that the good results are due to the excellence of the optical work, and have been obtained in spite of, and not by reason of, the peculiar form of the instrument.

And now I would say a few words generally on the comparison which has been instituted between the two forms. The claims of the instrument which I propose are very modest. I simply claim for it that by its peculiar construction I can obtain an instrument of large aperture at about one-fourth the usual cost, and that the observer can be situated in a most comfortable position, and free from all the various inconveniences of ordinary observing. I do not claim that the instrument will be one of precision, or that the images will be better after reflection from the mirrors, or that it will be universal, or that it will do all and everything which the equatorial *coudé* will do at four times the cost. What the equatorial *coudé* claims your readers already know. Like many other matters, this also will probably resolve itself into one of cost. If a director of an observatory has 1760*l.* at his disposal, it is for him to decide whether he will have a 12-inch equatorial *coudé*, which commands the whole visible heavens, or a 24-inch telescope on my plan, sacrificing in this case about 20° near the Pole; or, putting it another way, he may consider the question whether he will spend 1760*l.* on a 12-inch equatorial *coudé* or 500*l.* on one of my form of same aperture.

On this matter I shall have more to say in my second letter, in which also I propose to answer all the various objections M. Lœwy has raised to my form. It may, however, be interesting for him to learn that, with a single unimportant exception, he has not raised an objection which has not already been discussed and provided for in the new instrument; but he has suggested to me another objection to the equatorial *coudé* which I shall also treat of in that letter. HOWARD GRUBB

Rathmines, Dublin, May 19

The Earthquake

MY yacht, the *Glimpse*, lay on the ground in the River Colne at East Donyland, about half a mile above Wivenhoe, and as soon as I was able I joined her in order to study the effects of the late earthquake. I remained in the district about a fortnight, and examined the greater part of the focus of disturbance, over an area of about eight miles long by six broad. I distinguished on the ordnance map by appropriate marks (1) those places where the shock had been so violent that not only nearly all the chimneys had been knocked down but a large proportion of the house walls cracked and some boundary walls thrown down; (2) those where it had been less violent, many of the chimneys having been thrown down, but few or no houses cracked; and (3) those where it had been only sufficiently violent to throw down a few isolated chimneys. This third district extends in some directions much beyond the part examined. District No. 2 may be said to trend from Wivenhoe south-west to somewhat south of Little Wigborough, but sends a small, narrow branch north-west up the Colne valley to Colchester. The main part of District No. 1 is at Peldon, Langenhoe, and Strood Mill, but there are two well-marked outliers, one at Wivenhoe and another at Mortimer in Mersea Island. At and near Wivenhoe the intensity of the shock seems to have been greatest at low levels, and such a supposition would explain the character of that outlier, but no such explanation is applicable to the outlier at Mortimer, since the chief damage there is at a high level, and I was unable to discover any reason for its local character.

A great part of my attention was directed to such facts as indicated the direction in which the disturbance moved. The mate of the *Glimpse* was on deck, and says that the yacht was first, as it were, moved violently forwards to the west, and then even more violently backwards to the east. All the circumstances of the case make this a very good observation. In trying to determine the direction of the shock from the effects, I have taken great care to select such cases as would mark the first shock, and not the recoil. Unless this be done, no true result could be obtained, since very commonly the chimneys at one end of a house have been thrown down by the direct shock and those at the other end in the opposite direction by the recoil. On the whole I was able to observe nineteen cases which I looked upon as satisfactory. Almost all these vary from east to south. Perhaps the shock was rather more from the east at Wivenhoe than at Peldon. The mean of the whole is very nearly true south-east, which may be said to agree with the axis of chief disturbance as laid down by me on the map. The only case which is doubtful is that of the church at East Mersea. The manner in which two portions of the tower have been thrown down seem to indicate a shock from north-west. If this could be relied on with perfect confidence, it would show that the church lay on the south-east side of the vertical line, but I saw nothing else to confirm such a conclusion, and I think it quite as probable that the damage was done by the recoil which over the greater part of the district was from that same north-west direction. If this supposition is correct, the shock came up from below somewhat obliquely from south-east under East Mersea, where scarcely any damage has been done, and was most violent along the stroke of the wave at a distance of about three miles to the north-west. This and the general character of the area of chief disturbance seems to me to point to some very irregular distribution of hard rocks at a considerable distance below the surface. H. C. SORBY

Yacht *Glimpse*, Queenborough, May 25

IN your issue of the 8th inst. (p. 31) Dr. J. E. Taylor draws attention to the fact that sound preceded the Langenhoe earthquake for an appreciable period of time. A similar phenomenon has often been recorded, but as I cannot just now quote another instance, allow me to put forward a personal one.

On the morning of Monday, July 11, 1853, I had just gone to bed when I heard a heavy fast-approaching rumbling sound coming from the direction N.W. ¼ N. I was in St. Jean de Luz, and had stopped at an inn which skirts the high road from Bayonne to Madrid. The noise was coming nearer with the speed of an express train, and knowing that the only heavy coach which plied in those days could not pass at such an hour, I concluded that an earthquake was coming and got up to look at my watch, which I had left on a table at the opposite corner of the room; it was 20m. 8s. past midnight. When the noise seemed to issue from the ground *under* me, the whole house shook; it was then 24m. 8s. past midnight. Although occurring at a time when most of the inhabitants were asleep, this earthquake was recorded in all neighbouring villages and at Vera, on the south of the Pyrenees chain. This contradicts the observations made in Japan, where mountains seem to stop earthquakes. Taken unawares at St. Jean de Luz, I did not note down how long the sound lasted before and after the shock. This should be attended to, if possible, in all similar phenomena, for we have as yet no permanent self-recorder of sound.

Although notable earthquakes are of rare occurrence in Europe, slight ones frequently happen. I have observed two microscopical ones near Hendaye. Our imperfect knowledge of their times and causes would be improved if our meteorological observatories had proper seismometers telling their own tales. Perhaps they should be of three kinds: for serious earthquakes, for slight shocks, and for earth-tremors. ANTOINE D'ABBADIE, de l'Institut

Paris, May 26

THE earthquake was felt by an invalid in bed at Dudbridge, a mile south-west of Stroud, Gloucestershire. The house stands on the Middle Lias. It was also felt at Stonehouse, three miles west of Stroud on the Lower Lias. The New Red dips under the Lias, about seven miles west of Stonehouse, at the well-known section at Westbury-on-Severn. It is presumed that the Carboniferous Limestone exists under the New Red. It is visible three miles to the west of Westbury.

May 23 A. SHAW PAGE

Instinct in Birds

I READ with special interest the letter signed "Wm. Brown" in NATURE of the 15th (p. 56). I regret I cannot see the letter to which it refers. My excuse for intruding on your limited space is that I have something to say about a magpie's nest. My text is words in Mr. Brown's letter, "I have often seen the nest shot down." Some years ago seeing a magpie fly from her nest I climbed the tree to see what was in it. I found six eggs, but *not magpies'*. They were *starlings'* eggs on which the magpie was sitting. I visited the tree several times, and always found the magpie sitting on the starlings' eggs. To my great regret, on finally coming to see how the magpie and her foster brood were getting on, I found a shot-hole through the nest, and magpie and eggs knocked to pieces. R. S. S.

Edinburgh, May 21

P.S.—My regret was the greater as I could easily have prevented this by asking a neighbour's keeper to let the nest alone. The magpie lays as a rule seven eggs. There were six starlings' eggs in the nest. I saw no starling near the place, and as it was in the middle of a dense fir wood, I was the more astonished to see starlings' eggs there.

A Remarkably Brilliant Meteor

TO-NIGHT, about 10.45 p.m., I was "stepping westward," about half a mile east of my house. Suddenly the ground before me was lighted up with noontide splendour by a luminary that was above me and behind me. Looking back I saw a meteor a good deal east of the Great Bear, and nearly as high in the sky. It was about as big as Venus, and of the same hue. It was speeding from north to south with a slight descent. Its course very soon came to an end. It left behind it a streak of duller lustre: this phosphorus-like trail vanished almost at once. The career of this meteor while that body was visible here, lasted little, if at all, longer than a minute, but its light was remarkably brilliant.

JOHN HOSKYNS-ABRAHALL

Combe Vicarage, Woodstock, May 20

Right-sidedness

AN unprofessional account of a case of paralysis lately in the West London Hospital may be of interest as corroborating the assertion of Mr. Wharton (in his letter of March 20) that in paralysis of the left side it is the right eye which suffers, and *vice versâ*. The left arm and leg of a child in the above hospital (whom I only knew as "Alice") were in almost constant jerking motion, and the left side of the face was motionless. The left eye, however, was normal and bright; while on the right side of the face, which did all the talking and laughing, the eye was half closed, and one could see under the drooping eyelid that the pupil was dilated till but a narrow margin of iris was visible.

E. H.

MODERN TRAVEL—A SCIENTIFIC EDUCATION

THE teaching of geography has come to rather a sad pass in this country, as was evident from the address of the President at the Anniversary of the Royal Geographical Society on Monday. The Society's examiner, Prof. Moseley, reports that it is entirely neglected in our public schools; and the Council of the Society have withdrawn the public schools medals which they have awarded for years, simply because there are so few candidates for them. In our great public schools geographical teaching has no recognised place; if taught at all it is only as a voluntary subject, which may or may not be taken at the caprice of the boys. Some attempt has been made to methodise the teaching of the subject in schools under Government inspection, but so far the result has not been very successful. No doubt the Science and Art Department and the University examiners have done much to improve the teaching of what is known as physical geography in our middle-class schools; but at the very best we are a long way from perfection in this important branch of education, which, were it not for unintelligent teachers and dry text-books, ought to abound with interest. One serious defect in our system of teaching the subject is the want of proper apparatus; maps are good enough in their way, but it is not easy to persuade the pupil that they represent anything more than a flat surface. They are a poor substitute for the models which we find in some Continental schools, supplemented as these are by large-scale, well-executed pictures of the leading natural and artificial features with which geography deals. If Miss North's gallery of pictures at Kew could be taken round the country at intervals for exhibition to our schools, it would do more for giving a real conception of what geography is than many text-books. Let us hope that the step taken by the Royal Geographical Society, in appointing an inspector to visit Continental schools and report on the whole subject, will lead to real reform.

Of course the most effective and impressive method of education in geography would be to take the pupil all over the world, and let him see with his own eyes the many wonderful and beautiful features of our earth, which as lists of dry names weary his soul in his text-book. This is a method recently followed to some extent in certain of the French high schools. The best pupils are taken during the vacation to some important foreign centre, like London or Berlin, Christiania or Stockholm, from which excursions are made to the leading natural and artificial features of the country. Every tourist is indeed more or less of a practical geographer, finding fresh energy, education, and interest in those very things which when at school he abhorred. But we fear that many tourists pass through a country, if not with their eyes closed, at least without any training whatever as to what they are to look for; and unless the best-intentioned tourists have been so far instructed, their travels will do them little good. Hence the great educational value of a carefully-compiled guide-book; and how important such a guide-book might be made as a means of geographical and scientific instruction may be seen from the handsome "Orient Line Guide" before us.[1] It is in most respects very different from any of the volumes with which Murray and Baedeker have made us familiar. It is meant neither for knapsack nor pocket, but evidently for the saloon table. It is a broad folio, handsomely printed and abounding in fine large-scale illustrations and maps by Maclure and Macdonald. Every one who has gone a long voyage must have felt its tedium in spite of amusements of all kinds; but with the aid of the "Orient Guide" every day ought to bring fresh interest and fresh means of instruc-

[1] "Illustrated Guide of the Orient Line of Steamships between England and Australia." Issued by the Managers of the Line. (London: Maclure and Macdonald.)

tion. The illustrations themselves are of much interest; plans and portraits of several of the magnificent ships of the Line, views of many places and scenes from Gravesend to New Zealand, star-charts which may furnish a nightly education in astronomy as well as navigation, and maps of all the countries along the route.

When we say the work is edited by the Rev. W. J. Loftie, it will be evident that it is of an unusually high stamp. The special feature of the text is that besides the information about the Line and its ships, instructions to passengers and such like useful hints, we have special articles on seamanship, navigation, natural history at sea, and weather at sea. All the leading features along both the Suez route and the Cape route are pointed out and information given about them as the voyage proceeds, while special chapters are devoted to all the Australian colonies, to Egypt, the Holy Land, Italy, European cities, and the mother country. Thus it will be seen that the "Orient Guide" is adapted for the use of voyagers from both ends of the route.

As a means of conveying some practical knowledge of science, and arousing an interest in the subject, the chapters on seamanship, navigation, meteorology, and natural history must be particularly useful. Under "Seamanship" we are informed about all the most important points in the structure and working of a vessel. Such common terms as "running," "reaching," "beating," are explained, as are also the causes of the various motions of a ship—rolling, pitching, scudding, and so on; the various rigs of ships, the different species of ropes and knots, the various phrases shouted in working the helm, and other terms in nautical phraseology. The chapter on navigation ought to be particularly welcome to landsmen; by means of it the mere progress of the vessel itself, the daily operations of the officers in connection therewith, the conduct of the compass, the reading of charts, the use of the sextant, the various methods of ascertaining longitude, the use of the log, and so on—all can be made to furnish the passenger with constant sources of interest, and give him some idea of the many and complicated scientific principles which underlie so apparently simple a matter as the navigation of a steam vessel. The chapter also contains much information about the stars and their utility to navigation. The star-charts which accompany the chapter are not overloaded with names, and will be found of real utility in detecting the leading stars and watching their nightly changes as the vessel proceeds on her course.

The chapter on natural history contains succinct information on the leading forms of animal life likely to be met with during the voyage—land, coast, and ocean birds, fish of various kinds, cetaceans, the nautilus, zoophytes; while the marvellous phenomenon of the luminosity of the sea is explained. By a study of the chapter on the weather at sea, passengers may be able to throw more intelligence and variety into that monotonous and never-ending topic of conversation.

The more purely geographical part of the work is done in considerable detail. All the features met with on both routes are described in the order of their occurrence. Then for the benefit of those going out there are several chapters on the various Australian colonies, on their various aspects, scientific, geographical, and economical. On the other hand, for the benefit of Australians there is a general chapter on European travel, and special chapters on Egypt, Sinai, and the Holy Land, Italy, European cities, and the mother country—all richly illustrated.

Thus it will be seen that the "Orient Guide" is something very different from the ordinary run of guide-books, and that with it as a constant companion on board ship, a voyage to or from Australia may be made a real education. We should like to see other companies follow the example so well set by that of the Orient Line; travelling by sea has now become so common that thus the serious defects of English education in geography might be largely remedied. But even the railway companies might follow the example. Several years ago we noticed a geological guide to some of the United States railways, in which the various formations along the routes were described in the order of their occurrence as the train proceeded. Something of a similar kind might very well be done for English railways, extending the programme, however, to other features besides those relating to geology. Meantime the Orient Line is to be congratulated on its enterprise, and on the intelligence which has guided the compilation of their handsome work. Mr. Loftie has not only edited the work, but written the chapter on Egypt, while other special subjects have been treated by Dr. Charles Creighton, Mr. G. Baden Powell, Commander Hull, and Mr. H. E. Watts.

THE LATE MONSIEUR WURTZ

We have received the following communication from a Paris correspondent:—

The *éloges* pronounced over M. Wurtz's grave and your estimate of his place in science, doubtless being prepared, will tell your readers the extent of his life-work as a chemist. Indeed the best monument that could be raised to his memory would be a list of the work that has come from the laboratory at the École de Médecine during his thirty-four years' direction. But your readers may perhaps also be interested to know something of M. Wurtz as he appeared to those who were his pupils at the time of his death.

The impression one had at the beginning of M. Wurtz's first lecture was one of utter surprise. Organic chemistry was no longer a dry science full of dry formulæ, tiresome, complicated and difficult to remember; for the whole series of chemical transformations appeared as some philosophical romance in which the atoms and groups of atoms had their own particular characters, and could in given circumstances be depended on to act in a particular way. Yet, notwithstanding the picturesqueness of expression, there was no sacrifice of scientific accuracy. His teaching was so skilfully designed that each of his phrases could be interpreted immediately by the theories of thermo-chemistry and dissociation, which the more advanced student would learn later to apply to the study of organic chemistry, and by whose help the science is being gradually brought more and more to a purely physical stage. In the same way the psychology of the individual characters in life may some day be capable of being interpreted by purely physiological results. But notwithstanding the assertions of some eminent chemists, and notably of Wurtz's great rival Berthelot, no more in chemistry than in psychology is the problem thus reduced to one of rational mechanics. It seems, on the contrary, that for the accomplishment of this end account must inevitably be taken of those atoms for which Wurtz fought so hard, and of which Berthelot and the École Normale still deny the probable existence.

Taken aback at first by the new way of presenting well-known facts, one was soon carried along by the stream of Wurtz's eloquence and by his enthusiasm; and as one came out of the theatre, though Wurtz never left his subject to go into transcendental digressions, one had a feeling of being raised from the common things of life—a feeling of being better in every way for the new revelation of scientific truth.

Wurtz's eloquence was exceeded only by his modesty. He spoke of and praised Hofmann's general method for the preparation of the compound ammonias without mentioning the fact that it was he who discovered and recognised the first compound of this type. He eulogised Berthelot's great discovery that glycerine is a triatomic alcohol, then spoke of the diatomic alcohols or glycols; but no one in the audience could have guessed that it was he who first gave an accurate interpretation to Berthelot's results, and that he followed up and confirmed his generalisation by the brilliant discovery of the glycols.

I cite but two cases out of many, for during the whole of his course Wurtz never alluded to one of his discoveries as being his own; and certainly from his own lectures his large audiences at the Sorbonne could have had no idea of the leading part he played in the grand development of modern organic chemistry.

Having already exercised his immense influence at the École de Médecine, he felt himself at too great a distance from his auditors at the Sorbonne, and while he was having a laboratory (still unfinished) built for him, he inaugurated last year a series of weekly *conférences*[1] under his own direction, which might well find their analogues in the English Universities. Each week M. Wurtz gave out two subjects (such as molecular weights, the paraffins, the ethers, &c.), and two students volunteered to give lectures (lasting from half an hour to three-quarters of an hour) on them the week following. The *conférences* were delivered in one of the large lecture-rooms to audiences of from sixty to eighty students; Wurtz himself sat at the end of the lecture-table and gave a kindly and helpful criticism after the *conférence* was over. The last of these *conférences* was given just three weeks ago by the writer of these lines, and M. Wurtz's kind words will always be a precious memory to him:—they were the last he was destined to utter in public.

Wurtz was a fine man, of commanding presence. To alleviate the organic disease from which he suffered, and from which he died, he began by his doctor's orders to work at gymnastics about ten years ago, and he was, notwithstanding his sixty-six years, an accomplished gymnast at the time of his death. The untiring activity of his mind appeared in a certain vivacity and restlessness of manner peculiar to himself; but one felt, as soon as one saw and spoke to him, that he was a straightforward, loyal-hearted gentleman.

M. Wurtz was followed to the grave not only by the official deputations from the Sénat, the Institut, and the various learned institutions with which he was connected, but also by hundreds of students, principally from the École de Médecine and the Faculté des Sciences, bearing, according to French custom, wreaths of flowers, and thus paid their last tribute to the memory of their loved master. One could not help noticing especially an immense wreath of white flowers, offered by the women-students of the Faculté de Médecine, as a testimony of their gratitude to the man who some fifteen years ago obtained permission for them to study in the Faculty, and whom they followed to his last resting place right across Paris from the Boulevard St. Germain to the cemetery of Père la Chaise.

The sympathy which M. Wurtz inspired in all with whom he came in contact, coupled with his great genius, gave him a personal influence beyond that of most men—for if he is dead to us in the body he is still living in the mind, aye, and in the hearts, of the thousands of students who have listened to him in rapt attention on the benches of the École de Médicine and of the Sorbonne. As he said of Dumas: *Forma mentis æterna.*

Paris, May 16

ROBERT ANGUS SMITH

ANOTHER of the men of the middle time has passed away. Early on Monday morning, the 12th inst., whilst Adolphe Wurtz lay dying at Paris, Angus Smith breathed his last at Glynwood, Colwyn Bay. Both men were of the same age, and both were pupils of the illustrious Liebig—students in the great chemical school of Giessen. Each, in a sense, was imbued with some one phase of the spirit of their many-sided master, but in a different manner: Wurtz spent his energies and won his greatest triumphs in the development of chemical theory, and in the elucidation of the structure of organic compounds; Smith had probably little knowledge of, and but little sympathy with, the theories of modern organic chemistry; and although possessed of his countrymen's love of metaphysics, and, as his writings show, capable of much abstract speculation, his conceptions of chemical constitution were probably, in the main, as mechanical as those of Dalton, whose disciple and chief interpreter he considered himself to be. His chief point of contact with Liebig lay in his recognition of the utilitarian side of his science: for upwards of forty years he laboured unceasingly to show how chemistry might minister to the material comfort and physical well-being of men—not in the manufacture of new compounds useful in the arts, or in the establishment of new industries,—but in raising the general standard of the health of communities by checking or counteracting the evils which have followed in the train of that enormous development of the manufacturing arts which is the boast of this century. Sweetness and light were fixed articles in Smith's creed. His love of fresh air, of pure water, of a green hillside was intense. "Where to, sir?" asked a cabdriver whom Smith had hailed on his way home, tired and longing for escape from beneath the dull, murky Manchester sky. "To the sun!" was the answer. And we are told that it was to the credit of that cabman that he did not take the old philosopher to some hostelry with the sign of Phœbus, but trundled him among the green lanes beyond the city's outskirts until it was time to turn the horse's head homewards. To keep the air in our towns fresh and wholesome, to restore the water of our streams to its pristine clearness, to preserve the freshness and verdure of the fields and woods, to sweeten the atmosphere of the crowded dwellings in cities,—this was the kind of work to which Smith dedicated his life, and at which he laboured to the very last. There have been greater chemists, no doubt; his name is not associated with any fundamental discovery in chemistry, and his attempts at theorising were not always very happy; but in his true vocation, as the chemist of sanitary science, Smith worked alone, and we have yet to find the man on whom his mantle has fallen.

Robert Angus Smith was born in the neighbourhood of Glasgow on February 15, 1817. When nine years of age, he was sent to the High School, and at thirteen he entered the University of Glasgow. He quickly showed that liking for the classics, and especially for Greek, which clung to him through life, and his mother, as usual among Scottish matrons, cherished the aspiration that her son should "wag his pow in a poopit." Whether this ambition was ever shared by her son is doubtful; at all events, such a career became impossible for Smith after hearing the preaching of Campbell of Row: he declared that he could not take "holy orders in a kirk which had expelled a man for being apparently both wiser and better than itself." On leaving the University he acted as tutor in various families in the Highlands and in London. What directed him towards science does not appear. In company with his brother John, who is known as the inventor of a chromoscope, and as the author of some speculations on the cause of colour and the nature of light, he had read the standard works of his time on natural philosophy and chemistry. When twenty-two years of age he found himself at Giessen, and after working under Liebig for some time he obtained his doctorate. He returned to England in 1841, and procured employment under Dr., now Sir Lyon, Playfair, in connection with the Health of Towns Commission. It was this circumstance which doubtless served to fix the direction of his future work. His earliest publication—a contribution to the then recently founded Chemical Society of London—was a paper on the air and

[1] I need hardly say all University lectures are quite free in France.

water of towns, and successive memoirs, with almost identical titles, made their appearance either in the Society's *Transactions* or among the Reports of the British Association. The Royal Society's Catalogue shows that Smith was the author of about thirty papers on air and water. These he eventually collected and published, with considerable additions, in the form of a thick octavo volume, entitled "Air and Rain, the Beginnings of a Chemical Climatology," with a dedication to his friend and teacher Liebig. This book shows Smith at his best and at his worst. It is full of facts and quaint out-of-the-way references; on the other hand, it is diffuse, and, as a piece of literary work, badly put together—faults difficult to avoid in a compilation based upon, or largely composed of, papers already published. That Smith had considerable literary skill, and a sound critical faculty, may be seen in the short memoir on Graham prefixed to the collection of that philosopher's papers brought together and published, with a reverential care, by the late Dr. James Young of Kelly. Smith had years before saturated his mind with the notions of the Hellenic atomists, even before the time he wrote his monograph on Dalton, and in this short prefatory memoir of some twenty pages he crystallises out his thoughts on the development of the atomic systems of Kapila, Leucippus, Lucretius, Newton, and Dalton, and shows with admirable lucidity Graham's true relation to these great thinkers. Smith, however, would never have made a good teacher, despite his wish, in early life, to connect himself with some place of higher chemical instruction. When at his best he was not an ineffective speaker; but he was wanting in power of exposition, and his metaphysical tendencies and his quaint playful fancy were only too apt to disturb the even tenor of a sustained description, or closely reasoned argument. No man, however, was more popular among young men, for he had a genuine sympathy with youthful aspirations, and a kindly way of drawing out and encouraging what was good in them, and there are dozens of men still living who have to thank the gentle, quiet-spoken philosopher and friend for their first step in life. He had, too, his countrymen's tenacity of friendship: it took a very violent wrench indeed to disturb a confidence once placed.

From 1842 Smith was closely connected with Manchester. In that year he settled himself in the town as a consulting chemist. Shortly afterwards he became a member of the Literary and Philosophical Society of Manchester—a society made famous by its connection with Dalton and the Henrys—and much of his work appears in the *Memoirs* and *Proceedings* of that body. In 1855-56 he became one of its honorary secretaries, in 1859 a vice-president, and in 1864-65 president. In his "Centenary of Science in Manchester," published a short time ago, he has sketched, in characteristic manner, the growth of that institution, and has sought to trace its influence on the development of scientific life in Lancashire.

In 1863 Smith was appointed Inspector-General of Alkali Works for the Government, and the somewhat delicate task of initiating the working of Lord Derby's Act fell to him. He performed this duty with characteristic tact and with every desire to avoid undue interference with the legitimate business of the alkali maker. The successful working of that Act is largely due to the manner in which Smith and his subordinates set it in operation. On the passing of the Rivers' Pollution Act he was made Inspector for England, and afterwards for Scotland. He held both these appointments up to the time of his death.

Angus Smith had a passionate delight in the Highlands, and the smell of a peat fire was to him as incense. He had something, too, of the Highlander's love of mysticism in his composition, and throughout his life he found pleasure in Celtic literature; and it was with a mind well stored with legends that he produced "Loch Etive and the Sons of Uisnach," published anonymously in 1879.

Smith lived the "quiet life" of Pope's philosopher. His temper was singularly even and placid: he had his checks and crosses, of course, like other men, and he was occasionally pained to find himself misunderstood. But nothing ruffled his calm. His perfect transparency, his charming simplicity, and a certain quiet playfulness of manner gained for him the sobriquet of "Agnus" Smith. Indeed, his sense of fun could see the latent humour in any situation. Even on his death-bed it was with him. Somebody had said that they were not going to part with him yet. "You will be clever people," he rejoined, with the old twinkle in his eye, "if you keep me here three days longer."

Smith became a member of the Chemical Society in 1845, and a Fellow of the Royal Society in 1857, and in 1882 the University of Edinburgh conferred the honorary degree of LL.D. upon him.

T. E. THORPE

NORWEGIAN GEODETICAL OPERATIONS[1]

THE first part of this publication, published in 1882, was reviewed in NATURE, February 8, 1883. The second part, now before us, consists principally of a series of tables giving the results of the observations at the following tidal stations:—Stavanger from 1881 to 1882, Throndhjem from 1880 to 1881, Kabelvaag from 1881 to 1882, and Vardoe from 1880 to 1882. These tables are arranged precisely as in the first part; it is therefore unnecessary to refer to them more particularly.

A description, accompanied by a drawing, is given of the self-registering apparatus used. The float, placed in a tube, is connected by means of a fine wire to a wheel 50 cm. diameter, and the wire is kept taut by a counterweight acting on a second concentric wheel. On the axis of these wheels, and rigidly connected to it, is a pinion 2·5 cm. effective diameter, working on a horizontal rack, to which the scribing pencil is attached. Thus the rise and fall of the tide is measured to a scale of $\frac{2\cdot5}{50}$ or $\frac{1}{20}$. A cylinder, on which is fixed the diagram paper ruled with hour lines, is placed horizontally below the rack, and is driven by a clock connected to it directly by means of gearing, and assisted by a weight attached to a string passing over a pulley. This apparatus is the invention of Lieut.-Col. Haffner, and is made by a watchmaker (G. P. Stenberg) at Bergen.

It is mentioned that, owing to a defect in the self-registering apparatus used at Oscarsborg and at Drontheim, and described in the first part, the observations are not as satisfactory as might be wished. In the instruments used at these stations the motion of the driving clock was communicated to the diagrams by means of a string, and it has been found that the variations in the amount of humidity and of temperature sufficiently affected the length of the string to cause appreciable errors. It should be understood that the readings were taken by means of hour lines ruled on the diagram paper; any alteration in the length of the string clearly affects the accuracy of the position of these hour lines. This source of error has been removed, and new observations taken, which will be published in a succeeding part.

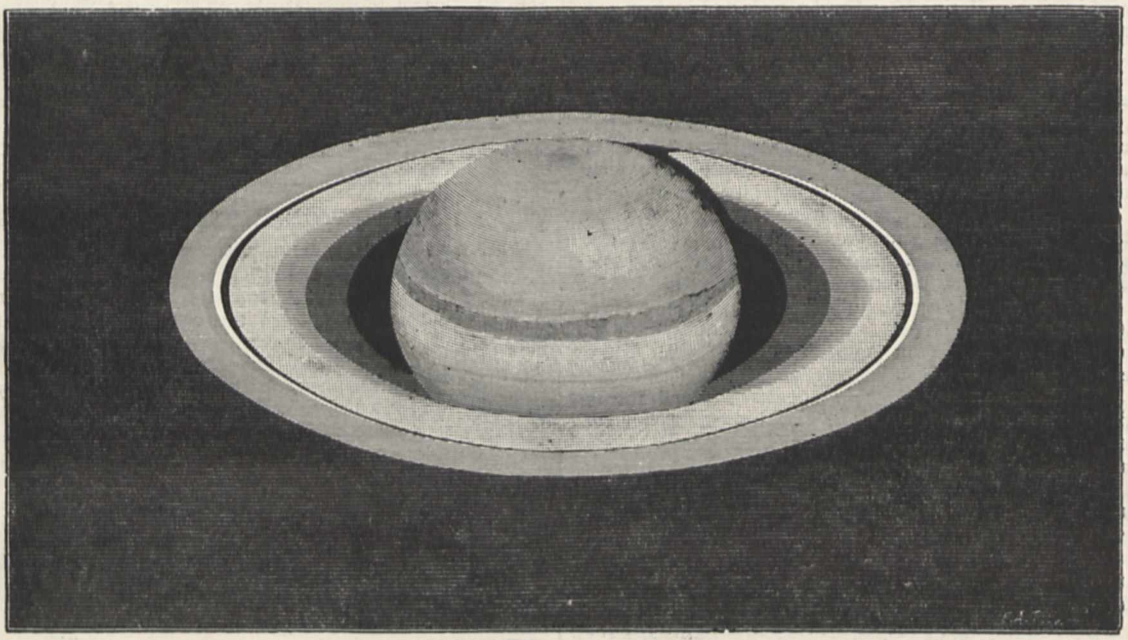
SATURN

MESSRS. PAUL AND PROSPER HENRY contribute to *La Nature* some interesting information on the recent aspect of the planet Saturn. During the month of February and the beginning of March last

[1] Publication of the Norwegian Committee of the Association for the Measurement of Degrees in Europe, Part II. (Christiania, 1883.)

several nights were of exceptional purity so far as regards the definition of stars observed in the telescope. Messrs. Henry say:—

"We took advantage of the most favourable moments to observe with our refractor of 0·38 m. the aspect of the principal planets; Saturn and his rings attracted our especial attention. The representations of this planet were often of remarkable precision, even when magnified more than a thousand times. It was possible to notice on several occasions curious inequalities in the equatorial band. Outside the known rings we established, around the principal separation (Cassini's division), the existence of a new ring, brilliant and perfectly defined, having a breadth of about 1⅓″. It is surprising that this ring, which is quite visible, has not hitherto been perceived. But the fact which more particularly struck us in observing Saturn, and which has induced us to publish the accompanying sketch, is that, notwithstanding extremely favourable conditions of visibility, it was impossible to discover the least trace of the external *anse* (Encke's division). That division, indicated since Encke by all the observers who have published drawings of Saturn, and which we believe we had also seen with instruments of moderate power, may well be only the result of an



Aspect of Saturn, March 4, 1884."

optical illusion. This phenomenon would be produced, in our opinion, by the brilliant ring which we have discovered, and which irradiation causes to appear larger than it really is, while by an effect of contrast we believed we saw, like a black line of separation, what in reality is only a marked difference in the brightness of the rings. By examining at a distance of about three metres the sketch here given, this division may be very clearly noticed as it is usually represented. The experiment will succed even better if one takes the precaution of slightly closing the eyelids. In these conditions the aspect of the drawing is pretty much that which Saturn presents when observed with instruments of ordinary dimensions, or even with powerful telescopes when the definition is imperfect. We may then explain by an optical illusion these differences of aspect observed in the external ring, without its being necessary to attribute them to any modification which has taken place in this curious appendage of Saturn. This interesting planet is now too near the sun for useful observations to be practicable. We shall continue our researches by means of powerful telescopes at the next opposition."

EARTH CURRENTS[1]

ONE of the most interesting subjects dealt with at the recent Electrical Congress in Paris was earth currents. The absence of published information in France on the behaviour of these erratic disturbers of telegraphic peace has led to an elaborate and careful study of the whole question by M. Blavier, the well-known and distinguished director of the High School of Telegraphy of the Post and Telegraph Administration in France. This has been printed, published, and circulated by the Minister of Posts and Telegraphs (M. Cochery) for the use of the members of the recent Congress.

These earth currents are always present in telegraph lines, varying in geographical and electrical direction and in strength, generally scarcely perceptible, but sometimes acquiring such intensity as to acquire the title of "storms." Their direction depends upon the direction of their earth terminals, and in no way on the route of the wires or on the fact of their being overground or underground. The longer the line the greater their strength. Their strength and direction vary with the hours of the day, and they show well-marked periods of maxima and minima. In fact there appears to be a tide in their affairs clearly following solar influence, and it has been believed by more than one observer that the influence of the moon is also perceptible. There is also an annual period of maximum and minimum, and this follows the well-marked eleven-year period of sunspots. We have just been passing through a period of maximum intensity. 1881 and 1882 were years of considerable activity. Their vagaries are exactly coincident

1 "Étude des Courants Telluriques," par E. E. Blavier. (Paris: Gauthier-Villars, 1884.)

with the variations of the mariner's compass, and are evidently primarily due to the same cause. It is when the aurora is present that they acquire extraordinary energy, and change their direction and intensity with great rapidity. Their effects are then observable simultaneously over the whole globe. They interfere seriously with the transmission of telegraph messages.

They have been studied and examined with great care in England. The eminent engineer, Mr. W. H. Barlow, F.R.S., was the first in the field, and his paper before the Royal Society in 1846 has scarcely been improved upon or added to. The late C. V. Walker was an incessant observer, and sent several papers to the Royal Society. Varley added considerably to our knowledge, and there are several papers by Mr. Preece, F.R.S., on their behaviour. The latter remarked that in the great storm of January 31, 1881, the currents acquired an electromotive force of ·3 volt per kilometre of earth surface and an intensity of 30 milliamperes—currents far stronger than those used for telegraphy. The *Proceedings of the Society of Telegraph Engineers* contain several interesting communications from Adams, Dresing, O. Walker, W. Ellis, Saunders, and others. It was warmly discussed at the Congress of 1881, which decided (1) that certain short lines in each country, independent of its general telegraph system, should be exclusively devoted to their study; (2) that long lines, particularly those underground, should be utilised as frequently as possible for the same purpose,—lines N. and S. and E. and W. being taken by preference, and one day per week—Sunday—being simultaneously employed for the purpose.

It was also suggested that during the year 1883 the 1st and 15th of each month should be taken for separate and careful observation. These resolutions have been faithfully carried out in Paris, and M. Blavier's work is the consequence. They have also been followed with great advantage in Germany and in Russia.

Permanent wires at right angles to each other have for many years been fixed and used in Greenwich, but the observations have not been systematically published, though the records are photographically printed.

M. Blavier has, since September 1883, organised a very careful system of automatic observation, by employing a clockwork apparatus similar to that designed by M. Mascart to register simultaneously the three components of terrestrial magnetism. He uses the dead-beat galvanometer of Deprez and d'Arsonval, shunted so as to meet the cases of all currents. As the chief point to be determined is the difference of potentials at the ends of a circuit, M. Blavier made the resistance of each long circuit examined equal to 10,000ω, and each short circuit 1000ω. The ordinates of the curve traced give indirectly the electromotive forces present. His excellent memoir contains a series of these curves, and very instructive they are. A complete lunar month from February 28 to March 28 is given. Observations were taken on aërial and underground wires. The general direction of maximum electromotive force in France is N.W.—S.E., making an angle of 56° with the magnetic meridian. M. Blavier concludes from the deflections of the needles that the disturbances of the magnetic elements are due to accidental electric currents circulating in the higher regions of the atmosphere although the earth currents circulate in the crust of the globe. He favours De la Rive's theory of the aurora borealis as being due to the circulation of electric currents in the higher regions of the atmosphere, in support of which he mentions several atmospheric effects well recorded as simultaneous with earth currents, such as intense scintillation of the stars observed by Montigny, and tempests. He associates earth currents with trade winds, and thereby indirectly with the sun.

Altogether M. Blavier's *brochure* is very ably written and a credit to the department of which he is such an old and distinguished member.

NOTES

The French Minister of Education and the Fine Arts has proposed to place at the disposal of M. Pasteur, for the prosecution of his scientific experiments, a large domain situated at Villeneuve-Etang, which belongs to the State.

Colonel Donnelly has been appointed Secretary and permanent head of the Science and Art Department of the Privy Council.

The Paris Academy of Sciences has nominated M. Cailletet, the inventor of the apparatus for the liquefaction of gas, a *Membre libre* in place of the late M. du Moncel. The Academy has appointed a Commission of six members to prepare a list of candidates for the office of Perpetual Secretary.

The death is announced of M. Bontemps, the author of several volumes on pneumatic telegraphy, and engineer to the French Government for the construction of the Paris system.

A committee has been formed at Alais (Gard) for erecting a statue in that city to M. Dumas. A committee will also be established for the erection of a statue to M. Wurtz in Paris.

The election of Dr. C. S. Roy to the new Professorship of Pathology at Cambridge augurs well for the scientific development of the rapidly-increasing medical school of that University. Dr. Roy's work, both as George Henry Lewes Scholar and as Professor-Superintendent of the Brown Institution, has, it is well known, been of the highest merit and promise.

The *conv. rsazione* of the Institution of Civil Engineers takes place to-night at the South Kensington Museum.

We are pleased to learn from a correspondent that the Natural History Department of the University of Edinburgh has undergone remarkable development during the last six months. Two years ago it had no lecture-room, and only one small room serving both as museum and laboratory. Now the old chemistry class-room, in which graduations and other ceremonials used to be held, and which is still the largest class-room in the University, has been handed over to the Professor of Natural History. There has not been time to have the class-room reseated, but the comfort of lecturer and students has been cared for in a still more important way, viz. by the erection of a ventilating fan, which changes the air several times every hour. The great demand for practical teaching which marked Prof. Ewart's advent to Edinburgh could only then be met with by resorting to a remote corner of the College buildings. Now the practical work is carried on in a splendid, beautifully decorated, well-lighted hall—a dingy museum in Jameson's time, but now capable of accommodating about 130 men at a time. In addition to this laboratory there is an adjacent smaller work-room for advanced students. A series of tanks is in process of erection in the lower room, which corresponds in size to the large laboratory, and which it is intended to convert into a laboratory provided with all the necessary apparatus for studying the life-history and development of marine organisms. When the other rooms which formerly belonged to the Natural History Department are added, the arrangements for teaching zoology in Edinburgh will be alike complete and satisfactory.

We understand that the University of St. Andrew is about to approach the Government with the view of obtaining funds for extending the Natural History Museum and at the same time for providing a marine laboratory within the walls of the University, while the more practical work of hatching, &c., which the Fishery Board for Scotland is carrying on will be provided for by a laboratory on the cliff immediately behind the College. It is proposed to prosecute the more purely scientific work within the walls of the College itself. The College is so near the proposed hatchery that the same pumping apparatus will serve for both laboratories, and thus, when established, the working expenses will be comparatively trifling. If the University and the Fishery Board succeed in carrying out their plans, biology will receive a mighty impulse at St. Andrew's, and the famous bay once more be peopled with an abundant supply of fish.

THE Clothworkers' Company have voted 2000*l.* towards the fund of 20,000*l.* required for the complete equipment of the new Central Institution of the City and Guilds of London Institute, this being additional to their original building grant of 10,000*l.* and their annual subscription of 3000*l.*

WE learn that orders have been given by the Inspector-General of the Imperial Maritime Customs of China, that meteorological observations made in the Treaty Ports and in the lighthouses are in future to be sent to the Government Astronomer at the Hong Kong Observatory, but that it is not at present the intention of the Chinese Government to start a meteorological service in China. With regard to observatories great progress has been made of late years. Central Government observatories exist in Japan, Peking (Russian), Hong Kong (British), and Batavia (Dutch), while the different Australian colonies which are covered with a network of minor meteorological stations, possess numerous central observatories, and it is very likely that this row of observatories will be extended further south, as steps are being taken to found an observatory in New Zealand, while the Russian Government is likely to extend its stations to the north of Vladivostock. First-class observatories are also supported by the Jesuit Order in Corea, China, and Manila, as well as elsewhere. For the investigation of typhoons, the terrible scourges of the China Sea, Father Faura, at Manila, has done most important work, and the utility of his observatory cannot but be extended when the Chinese Customs start self-recording meteorological instruments at South Cape, Formosa. But while each observatory is individually engaged in studying the peculiar features of its local climate in all its vicissitudes, it is by a comparison of the results exhibited in the different annual volumes published by each of them that we gain an insight into the laws that govern the general motions of the atmosphere and which underlie the peculiar features of each local climate. Thus in the China Sea the typhoons originate from local causes (heat and moisture), but the form and direction of their tracks are determined by the general laws of atmospheric motion in these regions.

THE first Circular of Information issued this year by the United States Bureau of Education relates to the approaching International Prison Congress at Rome in October next. The Bureau considers that the work of education is by no means limited to good children; and certainly, if no other power takes the reformation of the vicious in hand, their reform does become by so much the most important part of the work overlooked by this office, as they that are sick more need the physician than they that are whole. Prison Congresses were held in Europe in 1845, 1846, and 1857, and after an interval were revived through a paper by Count Sollohub of Russia, published in the Report of the New York Prison Association in 1868. His suggestions were adopted by Dr. E. C. Wines, the Secretary of that Society, and a Prison Congress was brought together at Cincinnati in 1870. Dr. Wines was elected Commissioner to act at an International Congress, and he brought about such meetings, first in London, then in Stockholm, and now at Rome. The questions for consideration are:—(1) As to the advantages from a reformatory view of imprisonment, and whether more useful and less degrading labour, without forcible detention, or even simple admonitions, might not be less mischievous and more effectual; as to length of sentence; as to finding the instigators to crime; and the treatment of juveniles. (2) Upon prison architecture, the keeping of new away from old offenders, Prison Commissions, prison hygiene, dietary and education, the rivalry between prison and free labour, and the remuneration of the former, and the use to be made of Sundays and holidays in the interest of education. (3) International arrangements, repression of vagrancy, and the desirability of societies for the help of discharged convicts.

ANOTHER of the Bureau's publications is a Report of the School of Classical Studies at Athens; and although this hardly falls under the head of Nature studies, yet a journal of science may note with satisfaction the spread of a scientific spirit which feels how far clearer is the knowledge of history after imbibing such object lessons as must be gained from an acquaintance with the climate and aspect of the country, and their natural influence upon the race inhabiting it, from the scene of the philippic, the fight, or the festival.

"To expedite school business and diminish future controversies" the United States Bureau of Education has published a digest of 700 law decisions, which have been made since Col. Eaton has been in office, upon all the details of education in that country. The number of States, each independent of all the rest, has added greatly to the labour of such a digest, and its recommendation that, while variety of systems should be encouraged in different States, uniformity of system should be enforced in each State seems to combine the greatest amount of practical advantage.

THE following alterations have been made in the arrangements for the Friday evening meetings at the Royal Institution:—Mr. Willoughby Smith will give the discourse on June 6, on Experiments in connection with Volta-Electric and Magneto-Electric Induction; and on June 13 (extra evening), Prof. Dewar will give a discourse on Researches on Liquefied Gases.

MESSRS. CHAS. GRIFFIN AND CO. announce the publication of a "Year-Book of the Scientific and Learned Societies of Great Britain and Ireland." It will give some account of the constitution and working of more than 600 societies, distributed under the following heads:—(1) Science generally; (2) Mathematics and Physics; (3) Chemistry and Photography; (4) Geology and Mineralogy; (5) Biology, including Microscopy and Anthropology; (6) Economic Science and Statistics; (7) Mechanical Science and Architecture; (8) Naval and Military Science; (9) Agriculture and Horticulture; (10) Law; (11) Medicine; (12) Literature; (13) Psychology; (14) Archæology. There will also be an appendix giving a list of the chief scientific societies throughout the world.

MESSRS. W. SWAN SONNENSCHEIN AND CO. request us to announce that the whole edition of Profs. Nägeli and Schwendener's work on the Microscope, which has been in the press for so long a time, and which would have been ready for publication in a few days, was destroyed in the recent disastrous fire in Paternoster Row. A new edition has been at once sent to press, and it is hoped that the work will be in the hands of the public very shortly, since the English editors of the book had already completed their revision of the proof-sheets.

PROF. A. E. VERRILL, *Science* states, has in the press a very important paper, entitled "Second Catalogue of Mollusca recently added to the Fauna of the New England Coast and adjacent parts of the Atlantic, consisting mainly of Deep-Sea Species, with Notes on others previously reported." These are chiefly derived from the dredgings of the Fish Commission, are well illustrated, and worked up in the full and careful manner characteristic of the author. It appears in the *Transactions of the Connecticut Academy of Sciences*, and is illustrated by Emerton.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mr. J. L. Ellis; a Black-backed Jackal (*Canis mesomelas*) from South Africa, presented by Mr. H. P. Plummer; a Spotted Eagle Owl (*Bubo maculosus*) from Africa, presented by Capt. Larner; a Nicobar Pigeon (*Calœnas nicobarica*) from the Indian Archipelago, presented by Mr. Thomas H. Haynes; a Herring Gull (*Larus argentatus*), European, presented by Dr. E. H. Cree; a Bonnet Monkey (*Macacus sinicus* ♂) from India, deposited; a Rabbit-eared Perameles (*Perameles lagotis*) from West Australia, two Specious Pigeons (*Columba speciosa*) from South America, purchased; a Bennett's Wallaby (*Halmaturus bennetti* ♂) from Tasmania, received in exchange; a Wapiti Deer (*Cervus canadensis* ♂) born in the Gardens.

GEOGRAPHICAL NOTES

IN *Petermann's Geographische Mittheilungen*, 1884, Heft iv., is an article on the island of São Thomé, accompanied by maps both of that island and of the neighbouring island of Rolas, by Prof. R. Greeff in Marburg. The contribution is the result of several months' residence on those islands in the course of a scientific tour through the islands of the Gulf of Guinea in 1879 and 1880. The map of the two islands in question is the united product of Prof. Greeff and of the proprietor of Rolas, Francisco José de Araujo: a map based partly on immediate exploration and observation, partly on careful information derived from natives. It both corrects and supplements in considerable measure the only two previous maps of St. Thomas known to the authors—that of 1829 by the English commander, T. Boteler, and that of 1844 by the Portuguese, Lopez de Lima. In the present map are entered for the first time the districts into which St. Thomas is divided, its "villas," its connecting highways, its more important plantations, and also the demarcation between the comparatively small cultivated part and the large wooded wilderness of the south and the interior. The map of Rolas is the first that has yet appeared of this island, which is intersected by the Equator. The history of St. Thomas is sketched from the year 1470, when it was discovered, without a single human inhabitant and almost wholly overgrown with forest, by the Portuguese sailors, João de Santarem and Pero de Escobar. Prof. Greeff calculates the dimensions of the island, which stretches ovally from 0° 2′ to 0° 30′ N. lat. and from 6° 34′ to 6° 54′ E. long., at about 52 kilometres by 34 kilometres, or altogether about 920 square kilometres.

WRITING from Bakundu-ba-Nambeleh in October 1883, St. von Rogozinski gives an account of his travels between Cameroon and Calabar. On August 13 he left the coast in company with Clemens Tomczek, made his way up the Mungo for Bakundu, his other fellow-travellers being bound for the station of Mondoleh. On September 11 they determined on traversing the region of the Upper Mungo as far as its falls. Making their way through thick forest and over mountain chains, they came on Eliki, where were three rapids, and from which point the Mungo is no longer navigable. The land to the north-east gets even more elevated, and the path of the travellers became continually crossed by streams. At length, at 4° 46′ 15″ N. lat. and 9° 33′ 30″ E. long., they looked down from a hill on the sources of the Yabiang or Abo, a deep and "indescribably beautiful" valley clothed in the most exuberant tropical vegetation. The principal town here is Balombi-ba-Kange, built like all towns of that quarter in the form of a crescent or arch, with fetish houses in the middle. On September 14 they left Kange, and passed the slave town of Bakú. Further to the north they entered, the same day, the large town of Mokonje, the centre of the ivory trade for the lands of Biafra Bay. Next passing Bao, they reached Mambanda, close to the falls and the new lake, Balombi-ba-Mbu, they were in quest of, on the 16th. Quite exhausted, and finding their way further to the north rendered impossible by troops of elephants and the want of any guide that would venture, they were reluctantly obliged to fall back on the mission station of Bakundu, where Rogozinski was compelled to stay and nurse the wounds on his feet and ankles. On the 23rd Tomczek resumed alone the march northwards by a different route, and happily reached the lake M'Bu at half a day's march from Boa. The beautiful lake is four miles long, of round shape, inclosed by thickly-wooded hills, is deep, abounds in fishes, and receives on the west the river Soho, six or seven metres broad. Apparently it is of volcanic origin.

IN a series of papers upon Early Discoveries in Australasia which Mr. E. A. Petherick, F.R.G.S., is contributing to the *Melbourne Review*, some curious and interesting facts are now made known for the first time, namely, the discovery of the west coast of Australia by the survivors of Magellan's expedition in 1522, the passage of Torres Straits by another Spanish vessel in 1545, sixty years before Torres, whose discovery and that of a Dutch vessel, the *Duyphen*, in the same year (1606) are hitherto the earliest authenticated accounts of the sighting of any part of the Australian coast by European vessels. But the most noteworthy statement Mr. Petherick makes is that the name of New Guinea belongs to that part of Australia now known as Queensland, and that the great island of Papua has borne the name of New Guinea erroneously for more than three centuries. Mr. Petherick is also able, from evidence upon a French *mappemonde* dated 1566, now in the Bibliothèque Nationale, Paris, to refute all claims to the discovery of Australia made at various times during the present and the last century on behalf of French navigators. Notwithstanding the early Spanish discoveries of Australia now referred to, Mr. Petherick asserts that the Portuguese were in the eastern seas twenty years earlier, and probably discovered Australia in the first decade of the sixteenth century.

LAST autumn the expedition under Lieut. Holm for exploring the east coast of Greenland, and which is again to start northwards this spring, met a party of about sixty East-Greenlanders —men, women, and children—south of the island of Aluk, on the east coast. They were on the way to the west coast to sell bear-, fox-, and seal-skins. Every attempt was made by the Danish explorer to induce some of them to return and act as guides on his journey northwards, but the prospect of a visit to a Danish settlement proved too great. A considerable number of East-Greenlanders die on their way to the west coast. The East-Greenlanders are reported to differ much from the West-Greenlanders in stature and appearance, the men being often tall, with black beards and European cast of face. This seems to be particularly the case with those living far north. Both East- and West-Greenlanders have small hands and feet. During the year 1883 four boats with heathen East-Greenlanders arrived at Julianshaab. Three of these came from the distant Angmasalik, and in them there were also, for the first time, natives from Kelalualik, which is five days' journey further north. The latter stated that in the winter they were in the habit, when journeying on sleighs, of meeting with people living much further north. Kelalualik being situated, it is believed, between lat. 67° and 68° N., it may be assumed that the whole line of coast from lat. 65° to 70° is to some degree populated.

FROM the annual report of the Russian Geographical Society for 1883 we learn that the meteorological observations of the Novaya Zemlya Station are expected to be published in full in the course of this year, while the observers of the Sagastyr Meteorological Station, on the Lena, have remained there for a year longer. The publications of the Society, besides the *Izvestia* have been the following:—Prjevalsky's third journey to Central Asia, Potanin's sketches of North-Western Mongolia, Karelin's travels on the Caspian, and Maynoff's anthropology of the Morovinians. The next publications will contain: the report of Unkovsky's embassy to Kontaisha under Peter I., M. Sadovnikoff's folklore of Samara, the third volume of M. Potanin's work on Mongolia, a geological map of the shores of Lake Baikal, by M. Chersky, the remarkable collection of maps of the delta of the Amu-daria, by M. Kaulbars, and the concluding fascicule of the capital work of M. Semenoff, the "Geographical and Statistical Dictionary of Russia." The great gold medal has been awarded to M. Severtsoff for his explorations in Turkestan, and Count Lütke's medal to Prof. Wild for his labours in Russsian meteorology, and for his work, "On the Temperature of the Air in Russia." The smaller gold medals were awarded to M. Lessar for his journeys, MM. Agapitoff and Khangaloff for their work on Shamanism in Siberia, M. Adrianoff for his journey to the Altay and Kuzuetzky Alatau, and M. Usoff, member of the West Siberian branch of the Society. Silver medals were awarded to Lieut. F. Schwatka and Mr. W. Hoffman, Secretary to the Anthropological Society of Washington; to MM. Andréeff, Grinevetsky, Konshin, Kosyakoff, Krivosheya, Kudryavtseff, Prince Urusbieff, Fuss, Wereschaghin, and Dobrotvorsky. The library has been increased by 4001 volumes.

THE MOVEMENTS OF THE EARTH[1]

IV.—*The Earth's Revolution*

IT will be clear from what has gone before that the daily movement of the stars is an apparent one due to the real movement of the earth in an exactly opposite direction, and that the stars in the heavens appear to rise in the east and set in the west, because the earth rotates from west to east. And now comes this question: The period of twenty-four hours which is so familiar, and which is divided roughly into day and night, has apparently two perfectly different sides to it; for a certain period the stars are not seen at all in consequence of a body, which we call the sun, flooding the earth's atmosphere with its own tremendous light. Why should this be? In giving an answer to this question it is enough to say that the sun is a star so close to us, and so entirely outshining the other and more distant stars which are seen in the skies, that they seem to be things of a different order altogether. But they are not things of a different order, they are very much like our sun, and the different appearance is simply the result of the fact that the one is a star very near to us, whilst the others are suns inconceivably remote. In considering this apparent daily movement of the stars, and taking the sun into consideration, the fact is soon arrived at that the stars have another apparent movement differing somewhat from that one with which up to the present time we have alone been engaged. It has been said, and it is so obvious that it might almost have been left unsaid, that as a rule the stars are not seen when the sun is visible, so that the question whether the sun moves or appears to move among the stars must be attacked in a rather indirect manner. An observer on that part of the earth's surface directly under the sun sees it as at midday. Under these conditions the stars are of course not seen by him, but if he waited twelve sidereal hours, until that portion of the earth which he inhabited was opposite the sun's place, the stars would then be visible, and by noticing whether those seen by him each night were the same, he would be able to determine whether or not the sun moved or appeared to move among them. In one position of the sun it occupies that constellation of stars known as the Bull. These stars cannot then be seen, because the intense brilliancy of the sun puts them out, but with the sun in this position the group of stars known as the Scorpion is seen opposite at midnight. Then at a later period the sun gets into the constellation called the Crab, and we see at midnight no longer the Scorpion group but the group which is called the Goat. In this way it can be determined that the sun has an apparent movement among the stars, which is completed in a period which we call a year, at the end of which time the sun occupies the same position that it did a year previously, and the same group of stars is seen again in the south at midnight.

Not only, then, do the stars appear to make a complete revolution once a day, in consequence, as we have seen, of the earth's rotation, but once a year they also gradually change their apparent places, so that at the same hour each night different stars appear due south, thus indicating a movement of the sun among them.

The same difficulty that was met with before is again encountered here; is this movement of the sun among the stars a real or an apparent one? It is a question, however, which has been long since answered; and it can be very definitely stated, not only that the earth rotates on its axis in a period of twenty-four sidereal hours, but that it moves or revolves round the sun in a period which we call a year, and that it is this real movement which causes the apparent one of the sun among the stars. Let the reader take a top and spin it. Perhaps the top has a movement of progression as well as a movement of rotation, and it is in that way quite easy to see that the earth may rotate on its axis and revolve about the sun at one and the same time. And with a top of special construction its axis of rotation might be inclined so that its plane of rotation ceased to coincide with the plane of its motion of progression; still the two movements would go on, and in whatever position the top might be placed, its axis might be made to remain practically parallel to itself during its movements.

We may now, then, make the following statements:—*The earth revolves round the sun, and throughout the revolution the axis of rotation remains practically parallel to itself.* With regard to the latter part of this statement it may be added that if this were not so—if the axis of the earth were subject to perpetual change of direction—the declinations of the stars would also be subject to constant change.

The demonstration of this movement of the earth round the sun depends upon physical considerations in exactly the same way as does the demonstration of the earth's movement of rotation, and to these considerations attention must now be turned. It will be found that we have now to do with an entirely different branch of physics to that which we drew upon when seeking for a proof of the rotation. The utilisation of its principles for the purposes of astronomy is due to Dr. Bradley, a former Astronomer-Royal. In the year 1729 he made a series of observations of stars, expecting certain results to flow from them. Instead, however, of getting the results for which he had looked, his observations gave him some which differed entirely from his predicted ones, and which he failed to understand. For such a thing as this to happen is a piece of good fortune for the scientific investigator; it sets him thinking and working, and frequently leads him to the discovery of some hitherto unknown physical law. It set Dr. Bradley thinking and working. Curious as it may seem, the observation which led him to a complete understanding of this subject was what he observed one day when a boat at anchor near the shore at Greenwich began to get under weigh in a stiffish breeze. The little boat had one of those short pennants on its mast, and Dr. Bradley noticed that, as soon as the boat began to move, the direction of the wind, as indicated by the movements of this pennant, changed. Before proceeding to consider the bearing which this fact, seemingly remote from astronomy, has upon star work, it may be advisable to take one or two simple illustrations which will show what must have passed through Bradley's mind as the explanation of the strange unexpected movements of the stars was slowly growing within it. The first illustration is one due to Sir George Airy. Suppose that a vessel is passing a fort, and that a shot is fired from the fort at the moving vessel. The shot will travel in a straight line; but it is evident that since the ship is moving, if that shot really pierces both sides of the vessel, then a line joining the spot where the ball pierced the one side to the spot where it pierced the other side will not be square to the direction of the ship's motion. During the short time taken by the shot to pass from one side of the ship to the other, the vessel has moved through a certain small distance, and if the line joining the two shot-holes were alone considered, it might be inferred that the shot had come from a direction in advance of the true one. That is one illustration, the point of it being that the motion of the vessel seems to have given a new direction to the shot. Take another illustration, more familiar, and perhaps almost as clear. In this country frequent opportunities offer themselves of travelling in cabs or railway trains, with the rain falling on their closed windows. Every one must have noticed that at such times there is always a very curious slant in the apparent direction of the drops whilst the train or the cab is in motion; the rain seems to come from a point in front of us; we always seem to meet the rain. The fact is that a body in motion, and especially a body with the velocity of an express train, does not receive the rain under the same conditions as when it is at rest. The question of its velocity has to be taken into consideration. An experiment will show better what is meant.

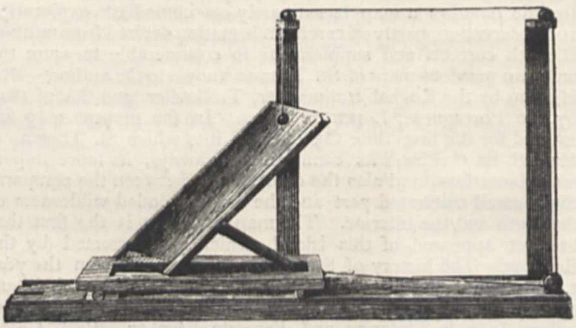


FIG. 35.—Model to illustrate the aberration of light. A square tube, with glass front and a slit along the centre of its upper side to allow the passage of a thread, is inclined at 45° and caused to run along a level track, while a weight suspended from a thread passing round three pulleys and attached at the other end to the front of the carriage is allowed to descend. In this figure the weight is at the commencement of its fall.

[1] Continued from vol. xxix. p. 205.

Imagine a weight supported by a piece of thread; the moment that thread is cut the weight falls in a straight line to the ground. If it be desired, therefore, to receive the falling weight in a tube at rest under the weight, and to so receive it that it shall not touch the sides of the tube as it passes through, the tube must be held in an upright position. Take another step, and suppose now that it is a question of causing the weight to fall through the tube whilst the tube itself is travelling at a certain rate, say at

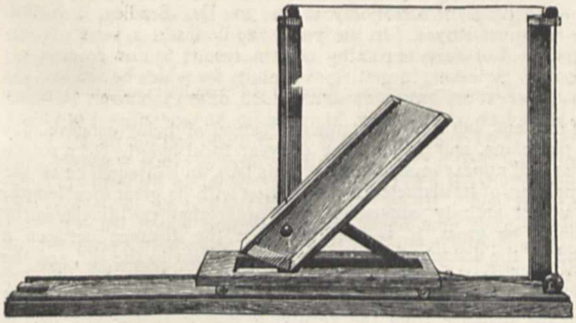


FIG. 36.—Same apparatus as preceding, but with the weight near the end of its fall.

the velocity of the falling weight. It is perfectly obvious that this cannot be done by holding the tube in a perpendicular position, the tube must be inclined, and the angle of its inclination will vary with the varying relative velocities of tube and weight. The more quickly the weight falls the less inclined must the tube be to receive it. This not only supplies the explanation of the slant of the rain on the windows of the railway carriage, but it explains what is very much more important from an astronomical point of view. Consider Fig. 37 for a moment. Here AB represents the path of anything falling, and aCB the angle of the tube destined to receive it. It may be called the angle of slant, but the point is not that we give it any particular name, but that its relation to the velocity of fall is a very fixed and definite one. Accept it as such, and then connect it,

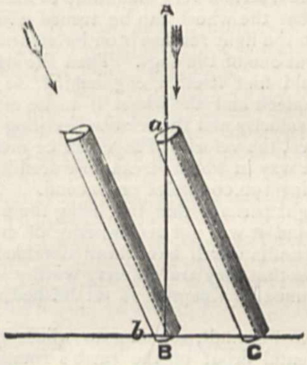


FIG. 37.

not with the falling weight or with the slant of the rain, but with the velocity of the light coming to the earth from any star in the heavens, and the velocity of the earth in its orbit round the sun.

It may be said that two assumptions are here made, first that light has a velocity, and secondly that the earth does move round the sun. Consider, then, the first of these, the question of the velocity of light. In our day, with all the experimental methods

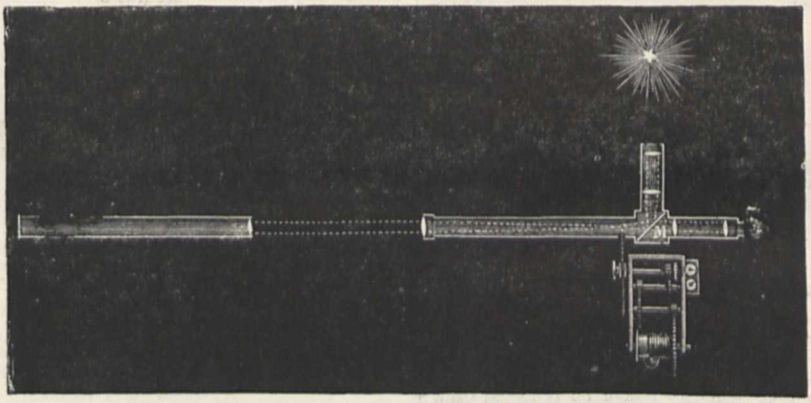


FIG. 38.—Fizeau's mode of determining the velocity of light.

and niceties which the labours of those who have gone before have placed at our disposal, this question of the velocity of light can be answered by what may be called a laboratory experiment. The first real attempt to answer the question was made some years ago by a Frenchman, M. Fizeau. His method of observation was a beautifully simple one, and has turned out to be highly satisfactory in its results. All the essential parts of his apparatus are shown in Fig. 38. Light from a lamp was made to pass through a system of lenses and was brought to a focus after reflection from the front surface of a piece of plain glass. The light was then grasped by an object-glass and sent out in a parallel beam to a station distant about five miles. There it fell on another object-glass, which again brought it to a focus on a mirror at the end of this second telescope. Then having got the light to the second mirror, it was reflected on its path back again. When the reflected light returned, part of it was allowed to go through the plain glass mirror to the eyepiece seen at the end of the telescope in Fig. 38. At the point where the rays crossed in the first telescope there was interposed the edge of a cogged wheel, to which a great velocity of rotation could be imparted by clockwork, and through the intervals between the teeth of which the light had to pass. Suppose first that the wheel is at rest. The lamp is lighted, and looking through the cogs of the wheel the observer sees the image of the lamp reflected back to him as a star of light from that distant

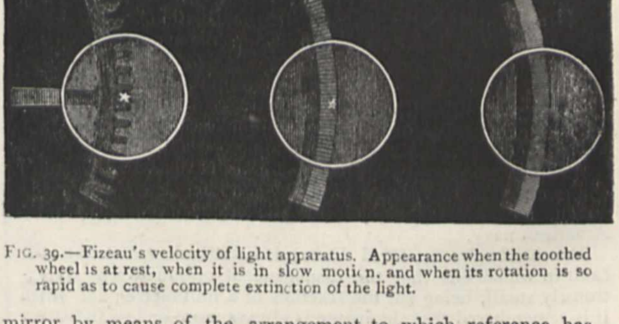


FIG. 39.—Fizeau's velocity of light apparatus. Appearance when the toothed wheel is at rest, when it is in slow motion, and when its rotation is so rapid as to cause complete extinction of the light.

mirror by means of the arrangement to which reference has been made.

Assume now that light occupies no time in travelling from the lamp to the first mirror, through the first telescope, across the space between the two telescopes, and back again after its reflection by the second mirror. Assume, in fact, that the velocity of light is infinite, then it is perfectly clear that an observer would keep on seeing that star of light whether the wheel remained at rest or were put in motion. But now assume that light does take a certain very small time to make the journey spoken of, and that the wheel can be turned with just such a velocity that when the light reaches it on its return it will meet, not an opening, but one of the cogs. Then the light would not be visible; it would find itself a cog behind, so that, if light travels very fast indeed and the wheel is made to travel with a great and known velocity and the relation existing between the velocities be known, the velocity of light can be measured in this way. That is the way in which Fizeau measured it, and he gave the velocity as being 190,000 miles per second.

It may be thought perhaps that this being the first attempt in a matter of this kind it was not very worthy of credit; but the similarity of the results which have been obtained in all such experiments proves that they are all very worthy of credit, and that this velocity must be accepted as established within narrow limits.

We come now to Foucault, the man to whose genius science owes the experimental proof of the earth's rotation, to which reference has already been made. He also attacked this question of the velocity of light. Going to work in quite a different way from Fizeau, he succeeded in enriching science with a method quite as reliable in its operation and as accurate in its results.

A pencil of light coming from a slit at S (see Fig. 40) impinges

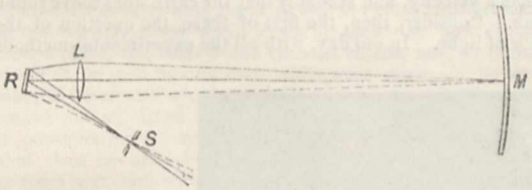


FIG. 40.—Foucault's arrangement for determining the velocity of light.

upon the plane mirror R, which is capable of turning round a vertical axis. This mirror reflects the light falling on its surface, and the action of the lens, L, causes an image to be formed on the surface of the concave mirror, M, the centre of which coincides with the axis at R. This concave mirror reflects the image backwards on its path to the slit. Foucault's arrangement, as has been said, was to have the mirror, R, made to rotate. If, therefore, R be turned about its axis while the light from the slit, S, is falling upon its surface, for so long as the light falls on the lens so long will the image of the slit be formed on the surface of the distant mirror. Similarly for so long as the reflected image falls upon the lens, so long will the image be reflected back to the slit. Now if the mirror were made to rotate rapidly, and light were infinite in its velocity, then once during each revolution of the mirror at one particular angle the light would be reflected back to the slit; but assume that light takes some very small fraction of time to travel over the space between the mirrors, it will be observed that the image will not be reflected back to the slit but will suffer a deflection in one direction or the other according as the mirror turns from left to right or from right to left, and, the velocity of the rotating mirror being known, the amount of this displacement will enable the velocity of light to be determined.

With two such different methods it might be supposed that the results obtained were very different. Not so, however; the velocity obtained by Fizeau was, as I have said, 190,000 miles per second, that by Foucault 185,000 per second.

It so happens that both these methods have been gone over quite recently, Fizeau's method by another Frenchman, M. Cornu, and Foucault's by Mr. Michelson, an officer in the American navy.

Mr. Michelson modified Foucault's method somewhat, the fault in which was that the displacement obtained was so extremely small, being but the fraction of a millimetre; and when it is remembered that the image is always more or less indistinct on account of atmospheric conditions and imperfection in the lenses and mirrors employed, it will be seen that it was difficult for Foucault to attain to any very great accuracy. Mr. Michelson therefore used an apparatus which would give him a greater deflection than that obtained by Foucault. As before, S (Fig. 41) was the slit, R the rotating mirror in the principal focus

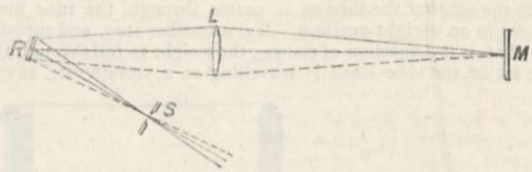


FIG. 41.—Michelson's variation of Foucault's experiment.

of the lens, but the distant mirror, instead of being concave, was a plane one, and the lens one of great focal length, for a reason that will appear immediately. This lens, in consequence of the smallness of its diameter in comparison with its great focal length, was not entirely convenient. In order that the displacement should be great, it is necessary that the distance between R and M, the distance from the revolving mirror to the slit, and the speed of rotation should be the greatest possible.

Unfortunately, the second condition clashes with the first,[1] for the distance from the revolving mirror to the slit, or the "radius" is the difference between the distances of principal and conjugate focus for the distant mirror M, and the greater the distance the smaller the radius. Two methods were employed by Mr. Michelson in overcoming this difficulty: first, he had his lens of great focal length, 150 feet, and he placed the revolving mirror, not at the principal focus, but fifteen feet within it. He thus managed to get a distance between the mirrors of 2000 feet with a radius of thirty feet, and his mirror made 256 revolutions per second. He then obtained a deflection of 133 millimetres, that being about 200 times greater than the deflection obtained by Foucault. This deflection he measured to within three or four hundredths of a millimetre in each observation.

Mr. Michelson's experiments were made along an almost level stretch of sea wall at the Naval Academy.

We are therefore justified in saying, as the result of these experiments of Fizeau and Cornu, Foucault and Michelson, that light has a velocity of some 186,000 miles per second.

If that be so, then, if the statement that the earth revolves about the sun be true, this must follow. In Fig. 42 *a*, *b*, *c*, *d*

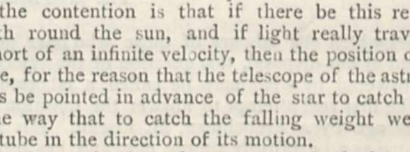


FIG. 42.—Annual change of a star's position, due to aberration: *a b c d*, the earth, in different parts of its orbit: *a' b' c' d'*, the corresponding aberration places of the star, varying from the true place in the direction of the earth's motion at the time.

represent the earth in different parts of its orbit around the sun; the contention is that if there be this revolution of the earth round the sun, and if light really travels with anything short of an infinite velocity, then the position of a star must change, for the reason that the telescope of the astronomer must always be pointed in advance of the star to catch its light in the same way that to catch the falling weight we had to incline the tube in the direction of its motion.

When any observation is made on any star in the heavens, the telescope of the astronomer must therefore be pointed in advance of the star to catch its light, and taking, as in the diagram, four different points in the earth's orbit, it is obvious that the telescope at these four different points must be pointed in four different directions with regard to the star. For instance, if we take a point at *c*, where the earth is travelling in the direction of the arrow, and the point at which the star would be seen if the earth were at rest, or the velocity of light were infinite, be indicated by the star in the figure, *c'* is the direction in which the star would be seen, and in which the astronomer's telescope must be pointed to catch its light. Similarly with the earth at *d* the telescope must be pointed to *d'*, and so with the earth at *a* we must have it pointing towards *a'*. It was this strange anomaly which puzzled Dr. Bradley in the year 1729.

[1] For full details of Michelson's experiments see NATURE, vol. xxi. p. 94 *et seq*

He noticed that the stars moved in ellipses every year round a mean point. This fact of aberration, then, is a real thing. It has been said that the angle at which the tube had to be inclined to receive the weight depended upon their respective velocities, that the faster the tube travelled, the greater must be its inclination, and therefore the greater the angle the greater the earth's velocity with reference to the velocity of light. In the case of the majority of the stars what we get is an ellipse, and in an ellipse we have certain differences which have to be taken into account, the last difference of all being that an infinitely elongated ellipse is a straight line, and it is found that from one particular point of the heavens where, in consequence of this aberrational motion, the orbits of the stars round their mean places are almost circular, we at last get to a point where the motion is simply an oscillation of the star backwards and forwards to and from its mean place; we are dealing, in fact, with that form of the ellipse when it is in the form of a straight line. When we deal with an ellipse we no longer talk of the radius, but of the semi-axis major, which is half the greatest length. The angle of aberration of which I have spoken only amounts to 20″·4451, but though small, it is quite enough to prove that the earth does revolve, and that consequently the sun is the centre of the system to which the earth belongs. Now in order to show the importance of physical inquiry in this matter, there is another statement which must be made. If we consider this aberration question fully, we find in it what is perhaps the most perfect way of determining the distance of the sun from the earth, and it will be seen that it is perfectly simple, so simple in fact, that the wonder is that more attention has not been given to it in our text-books. We have first the fact that the inclination of the tube depends upon the relative velocities of the tube and falling body; in the case of light it will of course depend upon the relative velocities of the earth in its orbit and light radiating from a star. Knowing this latter to be somewhere about 186,000 miles per second, and the aberration angle to be 20″ and something, we can get the relation of the earth's motion to the velocity of light, and it comes out to be about 1 to 10,089.

Now we know that the earth completes a revolution round the sun in 365¼ days. If it travelled with the velocity of light it would complete a revolution in 52m. 8·5s.

Again, we may say, and this is only a rough statement, that the radius of a circle is 1/6 of its circumference, so that if it took the earth fifty-two minutes to go round its circumference, or, as we call it, its orbit, it would take 1/6 of that time to go along the radius if it travelled with the velocity of light; it would therefore take 8m. 18s. But this radius is the distance of the earth from the sun, and having this time 8m. 18s., we have only to multiply the velocity of light[1] per second, by that, and we get 92,628,000 miles as the distance of the earth from the sun.

J. Norman Lockyer

(*To be continued.*)

[1] The exact value is 186,380 miles according to Michelson, with a possible error of thirty-three miles.

THE ROYAL COMMISSION ON TECHNICAL INSTRUCTION

We have just received from the Commission the two volumes of their second Report on Technical Education. We give this week the Recommendations with which the Commissioners conclude their Report:—

Having carefully considered what is desirable and practicable in regard to the general and technical instruction of the various classes engaged in industrial pursuits in this country, we humbly offer the following recommendations, which require the intervention of the Legislature or of public departments:—

I. As to public elementary schools:

(*a*) That rudimentary drawing be incorporated with writing as a single elementary subject, and that instruction in elementary drawing be continued throughout the standards. That the inspectors of the Education Department, Whitehall, be responsible for the instruction in drawing. That drawing from casts and models be required as part of the work, and that modelling be encouraged by grant.

(*b*) That there be only two class subjects, instead of three, in the lower division of elementary schools, and that the object lessons for teaching elementary science shall include the subject of geography.

(*c*) That, after reasonable notice, a school shall not be deemed to be provided with proper "apparatus of elementary instruction" under Article 115 of the Code, unless it have a proper supply of casts and models for drawing.

(*d*) That proficiency in the use of tools for working in wood and iron be paid for as a "specific subject," arrangements being made for the work being done, so far as practicable, out of school hours. That special grants be made to schools in aid of collections of natural objects, casts, drawings, &c., suitable for school museums.

(*e*) That in rural schools instruction in the principles and facts of agriculture, after suitable introductory object lessons, shall be made obligatory in the upper standards.

(*f*) That the provision at present confined to Scotland, which prescribes that children under the age of fourteen shall not be allowed to work as full-timers in factories and workshops unless they have passed in the Fifth Standard, be extended to England and Wales.

II. As to classes under the Science and Art Department, and grants by the Department:

(*a*) That School Boards have power to establish, conduct, and contribute to the maintenance of classes for young persons and adults (being artisans) under the Science and Art Department. That in localities having no School Board the local authority have analogous powers.

(*b*) That the Science and Art Department shall arrange that the instruction in those science subjects which admit of it shall be of a more practical character than it is at present, especially in the "honours" stage; that payment on results be increased in the advanced stages of all subjects, at least to the level of those now made for practical chemistry and metallurgy, and that greater encouragement be given to grouping.

(*c*) That the examinations in agriculture be made to have a more practical bearing.

(*d*) That metallurgy, if it be retained, be divided into groups, as (1) the precious metals, (2) those extracted from metalliferous mines, as copper, tin, lead, &c., (3) iron and steel. That mining be similarly divided into (1) coal and (2) metalliferous mining.

(*e*) That the inspection of science classes by the Science and Art Department, with a view to ascertain the efficiency of the instruction, and of the apparatus and laboratories, be made more effective, with the assistance, where necessary, of local sub-inspectors.

(*f*) That it shall not be a requirement of the Science and Art Department that payment of fees be demanded from artisans for instruction in the science and art classes.

(*g*) That in the awards for industrial design more attention be paid by the Department, than is the case at present, to the applicability of the design to the material in which it is to be executed, and that special grants be made for the actual execution of designs under proper safeguards.

(*h*) That the limits of the building grants, under the Science and Art Department, to 500*l*. each for schools of Art and of Science should be abolished, and the conditions attached to them be revised.

(*i*) That, in addition to the loan of circulating collections and the grant of art reproductions at reduced cost, contributions be made to provincial industrial museums of original examples tending to advance the industries of the district in which such museums are situated.

III. Training Colleges for elementary teachers:

(*a*) That the teaching of science and art in Training-Colleges, and its inspection by the Science and Art Department, be made efficient, and that arrangements be made for giving to selected students in those Colleges greater facilities and inducements for the study of art and science in the National Art Training School and the Normal School of Science at South Kensington, the Royal College of Science for Ireland, and other institutions of a similar class approved of by the Government.

IV. Secondary and technical instruction:

(*a*) That steps be taken to accelerate the application of ancient endowments, under amended schemes, to secondary and technical instruction.

(*b*) That provision be made by the Charity Commissioners for the establishment, in suitable localities, of schools, or departments of schools, in which the study of natural science, drawing, mathematics, and modern languages, shall take the place of Latin and Greek.

(*c*) That local authorities be empowered, if they think fit, to establish, maintain, and contribute to the establishment and maintenance of secondary and technical (including agricultural) schools and colleges.

V. Public libraries and museums:

(*a*) That ratepayers have power, by vote, to sanction the increase of the expenditure, under the Public Libraries Acts, beyond its present limit, and that the restriction of the Acts to localities having 5,000 inhabitants and upwards be repealed.

(*b*) That museums of art and science and technological collections be opened to the public on Sundays.

VI. Special recommendations in regard to Ireland:

(*a*) That steps be taken at the earliest possible moment for the gradual introduction of compulsory attendance at elementary schools in Ireland.

(*b*) That payments be made by the National Board, under proper regulations, on the results of the teaching of home industries to children, young persons, and adults; as well as in aid of the salaries of industrial teachers.

(*c*) That systematic instruction be given to primary school teachers, qualifying them to teach the use of tools for working in wood and iron, in the primary schools.

(*d*) That steps be taken by the Commissioners of National Education in Ireland for the provision of books calculated to assist the teachers of primary schools in giving graduated lessons in rudimentary science.

(*e*) That grants-in-aid be sanctioned by the Treasury to approved agricultural schools, and to approved schools for instruction in local industries.

(*f*) That practical evening science classes for artisans form part of the instruction in the Royal College of Science of Ireland, in Dublin.

(*g*) That the Board of Intermediate Education take steps to insure the provision of adequate means for the practical teaching of science in the schools under their direction.

In addition to the preceding recommendations which necessitate action on the part of the Legislature or of the public authorities, or of both, your Commissioners make the following recommendations, requiring no such action, by way of suggestions for the consideration of those in whose power it is to comply with them:—

I. That it be made a condition by employers of young persons, and by the trade organisations, in the case of industries for which an acquaintance with science or art is desirable, that such young persons requiring it receive instruction therein either in schools attached to works or groups of works, or in such classes as may be available, the employers and trade organisations in the latter case contributing to the maintenance of such classes.

II. That the managers and promoters of science and technical classes should (*a*) so arrange the emoluments of teachers as to encourage them to retain their students for the advanced stages of subjects in which they have passed the elementary stage, and (*b*) that they should endeavour to group the teaching of cognate science subjects, as recommended by the Royal Commission on the Advancement of Science, and as provided for by the regulations of the Science and Art Department.

III. That scholarships be more liberally founded, especially for pupils of higher elementary schools, enabling them to proceed to higher technical schools and colleges.

IV. That the great national agricultural societies give aid to the establishment in counties of secondary schools or classes for teaching agriculture.

V. That those responsible for the management of primary schools in Ireland, in the districts where farming is defective, attach small example farms to such schools wherever it is possible; and that Boards of Guardians employ the plots of land attached to workhouses for the agricultural instruction of the children therein.

VI. That the subscriptions given by the liberality of the City of London and of the different Guilds, to the City and Guilds Institute, be made adequate to the fulfilment of the work which that Institute has undertaken, including the equipment and maintenance of its Central Institution.

In closing our Report we think it right to recall the fact that the first impulse to an inquiry into the subject of technical instruction was given by the important letter of Dr., now Sir Lyon, Playfair, K.C.B., of May 15, 1867, to the Chairman of the Schools' Inquiry Commission, in which he called attention to the great progress in engineering and manufactures abroad, shown at the Paris Exhibition of that year. In the course of our inquiry we have received much guidance from the letter on the subject by Mr. B. Samuelson, M.P., to the Vice-President of the Committee of Council on Education, dated November 16, 1867; from the Report of the Select Committee of the House of Commons on Scientific Instruction, 1868; the Report of the Royal Commission on the same subject; the papers by Mr. H. M. Felkin on Chemnitz, by Messrs. McLaren and Beaumont, and various other publications.

We desire also to express our thanks to the public authorities, to the owners and managers of industrial works, and to the numerous other persons, both at home and abroad, to whom we had occasion to apply for information, for the frank and courteous manner in which it was given to us; and also to acknowledge the prompt and valuable assistance which we received from the members of our Diplomatic and Consular services in the prosecution of our inquiry. All of which we humbly beg leave to submit for Your Majesty's gracious consideration.

(Signed) B. SAMUELSON
H. E. ROSCOE
PHILIP MAGNUS
JOHN SLAGG
SWIRE SMITH
WM. WOODALL

GILBERT R. REDGRAVE,
Secretary,
April 4, 1884

ON THE NOMENCLATURE, ORIGIN, AND DISTRIBUTION OF DEEP-SEA DEPOSITS[1]

II.

Globigerina Ooze.—We designate by this name all those truly pelagic deposits containing over 40 per cent. of carbonate of lime, which consists principally of the dead shells of pelagic Foraminifera—*Globigerina*, *Orbulina*, *Pulvinulina*, *Pullenia*, *Sphæroidina*, &c. In some localities this deposit contains 95 per cent. of carbonate of lime. The colour is milky white, yellow, brown, or rose, the varieties of colour depending principally on the relative abundance in the deposit of the oxides of iron and manganese. This ooze is fine grained; in the tropics some of the Foraminifera shells are macroscopic. When dried it is pulverulent. Analyses show that the sediment contains, in addition to carbonate of lime, phosphate and sulphate of lime, carbonate of magnesia, oxides of iron and manganese, and argillaceous matters. The *residue* is of a reddish brown tinge. Lapilli, pumice, and glassy fragments, often altered into palagonite, seem always to be present, and are frequently very abundant. The mineral particles are generally angular, and rarely exceed 0·08 mm. in diameter; monoclinic and triclinic feldspars, augite, olivine, hornblende, and magnetite are the most frequent. When quartz is present, it is in the form of minute, rounded, probably wind-borne grains, often partially covered with oxide of iron. More rarely we have white and black mica, bronzite, actinolite, chromite, glauconite, and cosmic dust. Silliceous organisms are probably never absent, sometimes forming 20 per cent. of the deposit, at other times only recognisable after careful microscopic examination. In some regions the frustules of Diatoms predominate, in others the skeletons of Radiolarians.

The *fine washings*, viewed with the microscope, are not homogeneous. The greater part consists of argillaceous matter coloured by the oxides of iron and manganese. Mixed with this, we distinguish fragments of minerals with a diameter less than 0·05 mm., and minute particles of pumice can nearly always be detected. Fragments of Radiolarians, Diatoms, and siliceous spicules can always be recognised, and are sometimes very abundant.

Pteropod Ooze.—This deposit differs in no way from a Globigerina ooze except in the presence of a greater number and variety of pelagic organisms, and especially in the presence of Pteropod and Heteropod shells, such as *Diacria*, *Atlanta*, *Styliola*, *Carinaria*, &c. The shells of the more delicate species of pelagic Foraminifera and young shells are also more abundant in these deposits than in a Globigerina ooze. It must be remembered that the name "Pteropod ooze" is not intended to indicate that the deposit is chiefly composed of the shells of these mollusks, but, as their presence in a deposit is characteristic and has an important bearing on geographical and bathymetrical distribution, we think it desirable to emphasise the presence of these shells in any great abundance. It may here be pointed out that there is a very considerable difference between a Globigerina

[1] A Paper read before the Royal Society of Edinburgh by John Murray and A. Renard. Communicated by John Murray. Continued from p. 88.

ooze or a Pteropod ooze situated near continental shores and deposits bearing the same names situated towards the centres of oceanic areas, both with respect to mineral particles and remains of organisms.

Diatom Ooze.—This ooze is of a pale straw colour, and is composed principally of the frustules of Diatoms. When dry it is a dirty white siliceous flour, soft to the touch, taking the impression of the fingers, and contains gritty particles which can be recognised by the touch. It contains on an average about 25 per cent. of carbonate of lime, which exists in the deposit in the form of small *Globigerina* shells, fragments of Echinoderms and other organisms. The *residue* is pale white and slightly plastic; minerals and fragments of rocks are in some cases abundant; these are volcanic, or, more frequently, fragments and minerals coming from continental rocks and transported by glaciers. The *fine washings* consist essentially of particles of Diatoms along with argillaceous and other amorphous matter. We estimate that the frustules of Diatoms and skeletons of siliceous organisms make up more than 50 per cent. of this deposit.

Radiolarian Ooze.—It was stated, when describing a Globigerina ooze, that Radiolarians were seldom, if ever, completely absent from marine deposits. In some regions they make up a considerable portion of a Globigerina ooze, and are also found in Diatom ooze and in the terrigenous deposits of the deeper water surrounding the land. In some regions of the Pacific, however, the skeletons of these organisms make up the principal part of the deposits, and to these we have given the name "Radiolarian ooze." The colour is reddish or deep brown, due to the presence of the oxides of iron and manganese. The *mineral particles* consist of fragments of pumice, lapilli, and volcanic minerals, rarely exceeding 0·07 mm. in diameter. There is not a trace of carbonate of lime in the form of shells in some samples of Radiolarian ooze, but other specimens contain 20 per cent. of carbonate of lime derived from the shells of pelagic Foraminifera. The clayey matter and mineral particles in this ooze are the same as those found in the red clays, which we will now proceed to describe.

Red Clay.—Of all the deep-sea deposits this is the one which is distributed over the largest areas in the modern oceans. It might be said that it exists everywhere in the abysmal regions of the ocean basins, for the *residue* in the organic deposits which has been described under the names Globigerina, Pteropod, and Radiolarian ooze, is nothing else than the red clay. However, this deposit only appears in its characteristic form in those areas where the terrigenous minerals and calcareous and siliceous organisms disappear to a greater or less extent from the bottom. It is in the central regions of the Pacific that we meet with the typical examples. Like other marine deposits, this one passes laterally, according to position and depth, into the adjacent kind of deep-sea ooze or mud.

The argillaceous matters are of a more or less deep brown tint from the presence of the oxides of iron and manganese. In the typical examples no mineralogical species can be distinguished by the naked eye, for the grains are exceedingly fine and of nearly uniform dimensions, rarely exceeding 0·05 mm. in diameter. It is plastic and greasy to the touch; when dried it coagulates into lumps so coherent that considerable force must be employed to break them. It gives the brilliant streak of clay, and breaks down in water. The pyrognostic properties show that we are not dealing with a pure clay, for it fuses easily before the blowpipe into a magnetic bead.

Under the term red clay are comprised those deposits in which the characters of clay are not well pronounced, but which are mainly composed of minute particles of pumice and other volcanic material which, owing to their relatively recent deposition, have not undergone great alteration. If we calculate the analyses of red clay, it will be seen, moreover, that the silicate of alumina present as clay ($2SiO_2,Al_2O_3 + 2H_2O$) comprises only a relatively small portion of the sediment; the calculation shows always an excess of free silica, which is attributed chiefly to the presence of siliceous organisms.

Microscopic examination shows that a red clay consists of argillaceous matter, minute mineral particles, and fragments of siliceous organisms; in a word, it is in all respects identical with the *residue* of the organic oozes. The mineral particles are for the greater part of volcanic origin, except in those cases where continental matters are transported by floating ice, or where the sand of deserts has been carried to great distances by winds. These volcanic minerals are the same constituent minerals of modern eruptive rocks, enumerated in the description of volcanic muds and sands; in the great majority of cases they are accompanied by fragments of lapilli and of pumice more or less altered. Vitreous volcanic matters belonging to the acid and basic series of rocks predominate in the regions where the red clay has its greatest development, and it will be seen presently that the most characteristic decompositions which there take place are associated with pyroxenic lavas.

Associated with the red clay are almost always found concretions and microscopic particles of the oxides of iron and manganese, to which the deposit owes its colour. Again, in the typical examples of the deposit, zeolites in the form of crystals and crystalline spherules are present, along with metallic globules and silicates which are regarded as of cosmic origin. Calcareous organisms are so generally absent in the red clay that they cannot be regarded as characteristic; when present, they are chiefly the shells of pelagic Foraminifera, and are usually met with in greater numbers in the surface-layers of the deposit, to which they give a lighter colour. On the other hand, the remains of Diatoms, Radiolarians, and Sponge-spicules are generally present, and are sometimes very abundant. The ear-bones of various Cetaceans, as well as the remnants of other Cetacean bones, and the teeth of sharks, are, in some of the typical samples far removed from the continents, exceedingly abundant, and are often deeply impregnated with, or embedded in thick coatings of, oxides of iron and manganese. The remains of these Vertebrates have seldom been dredged in the organic oozes, and still more rarely in the terrigenous deposits.

The *fine washings*, as examined with a power of 450 diameters, are composed of an amorphous matter, fragments of minerals, the remains of siliceous organisms, and colouring substances. What we call amorphous matter may be considered as properly the argillaceous matter, and presents characters essentially vague. It appears as a gelatinous substance, without definite contours, generally colourless, perfectly isotropic, and forms the base which agglutinates the other particles of the washings. As these physical properties are very indefinite, it is difficult to estimate even approximately the quantity present in a deposit. However, it augments in proportion as the deposit becomes more clayey, but we think that only a small quantity of this substance is necessary to give a clayey character to a deposit. Irregular fragments of minerals, small pieces of vitreous rocks, and remains of siliceous organisms predominate in this fundamental base. These particles probably make up about 50 per cent. of the whole mass of the *fine washings*, and this large percentage of foreign substances must necessarily mask the character of the clayey matter in which they are embedded. The mineral particles are seldom larger than 0·01 mm. in diameter, but descend from this size to the merest points. It is impossible, on account of their minuteness, to say to what mineral species they belong: their optical reactions are insensible, their outlines too irregular, and all special coloration has disappeared. All that can be reasonably said is that these minute mineral particles probably belong to the same species as the larger particles in the same deposit, such as feldspar, hornblende, magnetite, &c. In the case of pumice and siliceous organisms the fragments can, owing to their structure, be recognised when of a much less size than in the case of the above minerals.

It can be made out by means of the microscope that the colouring substances are hydrated oxides of iron and manganese. The former is scattered through the mass in a state of very fine division; in some points, however, it is more localised, the argillaceous matter here appearing with a browner tinge, but these spots are noticed gradually to disappear in the surrounding mass. The coloration given by the manganese is much more distinct; there are small, rounded, brownish spots with a diameter of less than 0·01 mm., which disappear under the action of hydrochloric acid with disengagement of chlorine. These small round concretions, which are probably a mixture of the oxides of iron and manganese, will be described with more detail in the *Challenger* Report.

The following table shows the nomenclature we have adopted:—

Terrigenous deposits.	Shore formations, Blue mud, Green mud and sand, Red mud,	Found in inland seas and along the shores of continents.
	Coral mud and sand, Coralline mud and sand, Volcanic mud and sand,	Found about oceanic islands and along the shores of continents.

Pelagic deposits.	Red clay, Globigerina ooze, Pteropod ooze, Diatom ooze, Radiolarian ooze,	Found in the abysmal regions of the ocean basins.

Geographical and Bathymetrical Distribution.—In the preceding pages we have confined our remarks essentially to the lithological nature of the deep-sea deposits, including in this term the dead shells and skeletons of organisms. From this point of view it has been possible to define the sediments and to give them distinctive names. We now proceed to consider their geographical and bathymetrical distribution, and the relations which exist between the mineralogical and organic composition and the different areas of the ocean in which they are formed.

A cursory glance at the geographical distribution shows that the deposits which we have designated MUDS and SANDS are situated at various depths at no great distance from the land, while the ORGANIC OOZES and RED CLAYS occupy the abysmal regions of the ocean basins far from land. Leaving out of view the coral and volcanic muds and sands which are found principally around oceanic islands, we notice that our blue muds, green muds and sands, red muds, together with all the coast and shore formations, are situated along the margins of the continents and in inclosed and partially inclosed seas. The chief characteristic of these deposits is the presence in them of continental debris. The blue muds are found in all the deeper parts of the regions just indicated, and especially near the embouchures of rivers. Red muds do not differ much from blue muds except in colour, due to the presence of ferruginous matter in great abundance, and we find them under the same conditions as the blue muds. The green muds and sands occupy, as a rule, portions of the coast where detrital matter from rivers is not, apparently, accumulating at a rapid rate, viz. on such places as the Agulhas Bank, off the east coast of Australia, off the coast of Spain, and at various points along the coast of America.

Let us cast a glance at the region occupied by terrigenous deposits, in which we include all truly littoral formations. This region extends from high-water mark down, it may be, to a depth of over four miles, and in a horizontal direction from 60 to perhaps 300 miles seawards, and includes, in the view we take, all inland seas, such as the North Sea, Norwegian Sea, Mediterranean Sea, Red Sea, China Sea, Japan Sea, Caribbean Sea, and many others. It is the region of change and of variety with respect to light, temperature, motion, and biological conditions. In the surface waters the temperature ranges from 80° F. in the tropics, to 28° F. in the polar regions. Below the surface down to the nearly ice-cold water found at the lower limits of the region in the deep sea, there is in the tropics an equally great range of temperature. Plants and animals are abundant near the shore, and animals extend in relatively great abundance down to the lower limits of this region which is now covered by these terrigenous deposits. The specific gravity of the water varies much, owing to mixture with river water or great local evaporation, and this variation in its turn affects the fauna and flora. In the terrigenous region tides and currents produce their maximum effect, and these influences can in some instances be traced to a depth of 300 fathoms, or nearly 2000 feet. The upper or continental margin of the region is clearly defined by the high-water mark of the coast-line, which is constantly changing through breaker action, elevation, and subsidence. The lower or abysmal margin is less clearly marked out. It passes in most cases insensibly into the abysmal region, but may be regarded as ending when the mineral particles from the neighbouring continents begin to disappear from the deposits, which then pass into an organic ooze or a red clay.

Contrast with these, those conditions which prevail in the abysmal region in which occur the organic oozes and red clay, the distribution of which will presently be considered. This area comprises vast undulating plains from two to five miles beneath the surface of the sea, the average being about three miles, here and there interrupted by huge volcanic cones (the oceanic islands). No sunlight ever reaches these deep cold tracts. The range of temperature over them is not more than 7°, viz. from 31° to 38° F., and is apparently constant throughout the whole year in each locality. Plant life is absent, and although animals belonging to all the great types are present, there is no great variety of form or abundance of individuals. Change of any kind is exceedingly slow.

What is the distribution of deposits in this abysmal region of the earth's surface? In the tropical and temperate zones of the great oceans, which occupy about 110° of latitude between the two polar zones, at depths where the action of the waves is not felt, and at points to which the terrigenous materials do not extend, there are now forming vast accumulations of *Globigerina* and other pelagic Foraminifera, coccoliths, rhabdoliths, shells of pelagic Mollusks, and remains of other organisms. These deposits may perhaps be called the sediments of median depths and of warmer zones, because they diminish in great depths and tend to disappear towards the poles. This fact is evidently in relation with the surface temperature of the ocean, and shows that pelagic Foraminifera and Mollusks live in the superficial waters of the sea, whence their dead shells fall to the bottom. Globigerina ooze is not found in inclosed seas nor in polar latitudes. In the Southern Hemisphere it has not been met with beyond the 50th parallel. In the Atlantic it is deposited upon the bottom at a very high latitude below the warm waters of the Gulf Stream, and is not observed under the cold descending polar current which runs south in the same latitude. These facts are readily explained, if we admit that this ooze is formed chiefly by the shells of surface organisms, which require an elevated temperature and a wide expanse of sea. But as long as the conditions of the surface are the same, we would expect the deposits at the bottom also to remain the same. In showing that such is not the case, we are led to take into account an agent which is in direct correlation with the depth. We may regard it as established that the majority of the calcareous organisms which make up the Globigerina and Pteropod oozes live in the surface waters, and we may also take for granted that there is always a specific identity between the calcareous organisms which live at the surface and the shells of these pelagic creatures found at the bottom. This observation will permit us to place in relation the organic deposits and those which are directly or indirectly the result of the chemical activity of the ocean. Globigerina ooze is found in the tropical zone at depths which do not exceed 2400 fathoms, but when depths of 3000 fathoms are explored in this zone of the Atlantic and Pacific, there is found an argillaceous deposit without, in many instances, any trace of calcareous organisms. When we descend from the "submarine plateaus" to depths which exceed 2250 fathoms, the Globigerina ooze gradually disappears, passing into a grayish marl, and finally is wholly replaced by an argillaceous material which covers the bottom at all depths greater than 2900 fathoms.

The transition between the calcareous formations and the argillaceous ones takes place by almost insensible degrees. The thinner and more delicate shells disappear first. The thicker and larger shells lose little by little the sharpness of their contour and appear to undergo a profound alteration. They assume a brownish colour, and break up in proportion as the calcareous constituent disappears. The red clay predominates more and more as the calcareous element diminishes in the deposit.

If we now recollect that the most important elements of the organic deposits have descended from the superficial waters, and that the variations in contour of the bottom of the sea cannot of themselves prevent the debris of animals and plants from accumulating upon the bottom, their absence in the red clay areas can only be explained by a decomposition under the action of a cause which we must seek to discover.

Pteropod ooze, it will be remembered, is a calcareous organic deposit, in which the remains of Pteropods and other pelagic Mollusca are present, though they do not always form a preponderating constituent, and it has been found that their presence is in correlation with the bathymetrical distribution.

In studying the nature of the calcareous elements which are deposited in the pelagic areas, it has been noticed that, like the shells of the Foraminifera, those of the Thecosomatous Pteropoda, which live everywhere in the superficial waters, especially in the tropics, become fewer in number as the depth from which the sediments are derived increases. We have just observed that the shells of Foraminifera disappear gradually as we descend along a series of soundings from a point where the Globigerina ooze has abundance of carbonate of lime, towards deeper regions; but we notice also that when the sounding-rod brings up a graduated series of sediments from a declivity descending into deep water, among the calcareous shells those of the Pteropods and Heteropods disappear first in proportion as the depth increases. At depths less than 1400 fathoms in the tropics a Pteropod ooze is found with abundant remains of Heteropods and Pteropods; deeper soundings then give a Globigerina ooze without these molluscan remains; and in still greater depths, as before mentioned, there is a red clay in which calcareous organisms are nearly, if not quite, absent.

In this manner, then, it is shown that the remains of calcareous organisms are completely eliminated in the greatest depths of the ocean. For if such be not the case, why do we find all these shells at the bottom in the shallower depths, and not at all in the greater depths, although they are equally abundant on the surface at both places? There is reason to think that this solution of calcareous shells is due to the presence of carbonic acid throughout all depths of ocean water. It is well known that this substance, dissolved in water, is an energetic solvent of calcareous matter. The investigations of Buchanan and Dittmar have shown that carbonic acid exists in a free state in sea water, and in the second place, Dittmar's analyses show that deep-sea water contains more lime than surface water. This is a confirmation of the theory which regards carbonic acid as the agent concerned in the total or partial solution of the surface shells before or immediately after they reach the bottom of the ocean, and is likewise in relation with the fact that in high latitudes where fewer calcareous organisms are found at the surface, their remains are removed at lesser depths than where these organisms are in greater abundance. It is not improbable that sea water itself may have some effect in the solution of carbonate of lime, and further, that the immense pressure to which water is subjected in great depths may have an influence on its chemical activity. We await the result of further researches on this point, which have been undertaken in connection with the *Challenger* Reports. We are aware that objections have been raised to the explanation here advanced, on account of the alkalinity of sea water, but we may remark that alkalinity presents no difficulty which need be here considered (Dittmar, "Phys. Chem. *Chall.* Exp.," part i. 1884).

This interpretation permits us to explain how the remains of Diatoms and Radiolarians (surface organisms like the Foraminifera) are found in greater abundance in the red clay than in a Globigerina ooze. The action which suffices to dissolve the calcareous matter has little or no effect upon the silica, and so the siliceous shells accumulate. Nor is this view of the case opposed to the distribution of the Pteropod ooze. At first we should expect that the Foraminifera shells, being smaller, would disappear from a deposit before the Pteropod shells; but if we remember that the latter are very thin and delicate, and, for the quantity of carbonate of lime present, offer a larger surface to the action of the solvent than the thicker, though smaller, Globigerina shells, we shall see the explanation of this apparent anomaly.

(*To be continued.*)

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Special Board for Mathematics has reported in favour of an interval of one year being allowed between the second and the third parts of the Mathematical Tripos, instead of seven months as at present. It is also suggested that the work done in the first two parts of the Tripos has deteriorated in consequence of being held in the latter part of the Easter Term, when men are subject to many distractions.

The new buildings for the Department of Practical Botany are to be proceeded with forthwith, and thus Dr. Vines will gain the much-needed accommodation he has so long waited for.

The thanks of the University have been voted to Sir A. Gordon and to Mr. A. P. Maudslay for their presents of valuable ethnological collections, made by them in Fiji, to the new Museum of Archæology.

The eighteenth annual report of the Museums and Lecture-Rooms Syndicate draws attention to the pressing need of additional accommodation for Human and Comparative Anatomy and for Physiology. Nothing can be done to enlarge the provision of Human Anatomy till the new Chemical Laboratory is completed. A further report as to the accommodation for Physiology and Comparative Anatomy will be made shortly.

Profs. Liveing and Dewar report that additional special courses for medical students have been established. Lord Rayleigh reports that the elementary demonstrations on Physics in the Cavendish Laboratory are attended by forty students, the advanced by twenty, and the professorial lectures by from twenty to thirty students. Numerous additions of physical apparatus have been made during the year.

Prof. Lewis records a continued improvement in the Mineralogical Museum. Prof. J. P. Cooke of Harvard has presented a large and fine series of American specimens. Mr. G. Seligman of Coblentz has sent specimens far exceeding in value those for which they were exchanged. Mr. Solly brought back many excellent specimens from a tour in Norway; and the late Mr. Tawney's polariscope and optic sections have been presented by his brother.

Prof. Stuart has added some large machines to the Mechanical Department. There were sixty-one pupils in the Lent Term, and their work continues to improve. He states that Mr. Lyon's services are of extreme value as superintendent of the workshops, for he combines practical experience and theoretical knowledge in a manner rarely to be met with.

The additions to the Woodwardian Museum include twelve or fourteen thousand specimens, the collection of the late Mr. Montagu Smith, B.A., of Trinity College, a promising young student of geology, given by his parents in fulfilment of his expressed wish. They include several thousand specimens from all the crags of Norfolk and Suffolk, a rich collection of Chalk mollusca from Berkshire, mollusca from the Gault of Folkestone, the Farringdon sponge-bed, and specimens from many Jurassic localities. Mammalian remains from the Hamstead Beds, Isle of Wight, and Vertebrates from the Gault of Folkestone have been purchased. A number of interesting specimens from the Welsh Palæozoic strata, from Lower Llandoveny down to Harlech, have been added by Mr. T. Roberts. The Library continues to increase largely.

Mr. J. W. Clark reports that the collection acquired from Dr. Dohrn, exhibited at the Fisheries Exhibition, turns out much more valuable than was anticipated, there being 283 species of Invertebrates, and 38 of fishes in it, each being usually represented by several specimens. All are in first-rate order, and exceptionally good specimens. Mr. H. B. Brady has announced his intention of presenting all his valuable collections of Rhizopoda, chiefly Foraminifera, to be forwarded as the monographs relating to them are completed. Large instalments have already arrived, including the collection of British brackish-water and estuarine forms described in *Ann. and Mag. Nat. Hist.*, 1870, the North Polar Foraminifera from the Nares Expedition, the Carboniferous and Permian Foraminifera ("Pal. Soc. Monograph"), a large series of the genus Fusulina, a collection of the genera Nummulites and Orbiloides, numerous specimens of Loftusia and Parkeria, Nummulites from Egypt, and microzoic rocks illustrating the extent to which Forominifera are concerned in the building of geological strata.

Mr. Cooke, Curator in Zoology, has catalogued and arranged the specimens of Murex, Purpura, Triton, Fasciolaria, Buccinum, Nassa, Fusus, Voluta, and Mitra, and related genera.

Mr. Hans Gadow, Strickland Curator, has been occupied in arranging the collection of birds' skins in a systematic way, and preparing to exhibit the groups in a complete manner, skins, skeletons, viscera, nests, and eggs, in juxtaposition, but want of space, cases and drawers, is a great hindrance. Valuable donations of birds' skins have been received from Major H. W. Feilden (Natal), Lady Barkly (Penang), and Mr. C. E. Lister (St. Vincent, Antilles), and in exchange from the Australian Museum, Sydney (New Guinea species).

The Morphological Department records good progress; many diagrams and models have been added owing to the liberality of Trinity College, and much valuable material has been brought by students who have visited foreign countries for purposes of morphological research. The Balfour Library is of great value, and Mr. A. J. Balfour, M.P., is defraying the cost of continuing the periodicals. Twelve students have been engaged in research; seventeen have worked in the advanced class; forty-four worked at embryology last year, while nearly fifty have worked at Elementary Morphology during the past winter. Overwhelming pressure has been put upon the department owing to the new arrangements for Elementary Biology in the M.B. examinations; 201 students entered it last term, belonging to more than one year, and no lecture-room or work-room has proved adequate for them all. The work of research, storage of material, and administration of classes are much interfered with by want of suitable rooms, and new rooms are urgently needed. A bust of Prof. Balfour, executed in bronze by Hildebrandt of Florence, has been presented to the Laboratory by Prof. Darwin and Mr. J. W. Clark.

Prof. Michael Foster reports that the teaching of Physiology has been still further developed, but has suffered somewhat from the necessary use of the Laboratory by the class of Elementary

Biology. The generous gift by an anonymous donor of 500*l.* towards new apparatus has been a great boon. A gas-engine and many valuable pieces of apparatus have been added.

Prof. Macalister states that the number of students dissecting has been nearly one hundred, and a still larger number attended the lectures on Human Anatomy. Many important specimens have been presented to the Museum of Human Anatomy by Prof. Macalister.

The Philosophical Library is increasingly used, and many valuable donations of books have been received by Mr. J. W. Clark, Prof. Humphry, Prof. Babington, Mr. D. McAlister, and Mr. Pitman of Bath.

SCIENTIFIC SERIALS

American Journal of Science, May 1884.—Remarks on Prof. Newcomb's "Rejoinder," in connection with his review of "Climate and Time," by Dr. James Croll.—Communications from the United States Geological Survey, Rocky Mountain Division, VI.—On an interesting variety of Löllingite and other minerals (one illustration), by W. F. Hillebrand. Amongst the ores analysed by the author there is one from the Missouri Mine, Park County, Colorado, which he thinks may probably be a new mineral. It is composed largely of a sulphobismuthite of copper and silver, and occurs in a quartz gangue associated with chalcopyrite and wolframite.—Notes on American earthquakes, with tabulated record of seismic disturbances in every part of the continent during the year 1883, by Prof. C. G. Rockwood.—Thermometer exposure, by H. A. Hazen. The paper is chiefly occupied with questions relating to the locality in large regions where the thermometer should be exposed in order to obtain the most trustworthy results, and to the immediate environment of the thermometer best calculated to fulfil the same requirement. There are several comparative tables of results obtained with various instruments under varying conditions of time, aspect, and altitude.—Hillocks of angular gravel and disturbed stratification associated with glacial phenomena (four illustrations), by T. C. Chamberlain. The paper deals especially with the kames or eskers analogous to the osars of Sweden, occurring in various parts of New Hampshire, Massachusetts, New York, and Wisconsin. The author infers from their inherent characteristics and their association with morainic belts, that the gravel hills in question were formed, not by beach action, but by numerous marginal streams along the edge of the great ice sheet during the Glacial period.—Extinct glaciers of the San Juan Mountains, Colorado, by R. C. Hills.—On the gender of names of varieties and subspecies in botanical nomenclature, by Asa Gray.—On secondary enlargements of feldspar fragments in certain Keweenawan sandstones (four illustrations), by C. A. Vanhise.—Principal characters of American cretaceous Pterodactyls, part i., the skull of Pteranodon (with plate), by Prof. O. C. Marsh. The skull of these Pterodactyls from the Middle Chalk, West Kansas, is described as differing from that of other known Pterosauria in the absence of teeth and of anterior nasal apertures distinct from the antorbital openings; in the presence of the elongated occipital crest; lastly, in the whole jaws, which appear to have been covered with a horny sheath, as in recent birds. All belong to the genus Pteranodon, some of the species of which were of prodigious size, with a spread of wings of about twenty-five feet. Remains of over six hundred individuals are now in the museum of Yale College.

Journal of the Russian Chemical and Physical Society, vol. xvi., fasc. 2.—On the action of the bromide of aluminium on ethylene and on the bromides of saturated hydrocarbons, by M. Gustavson.—On the specific heat of solutions, and on the thermal effects at their formation, by W. Alexeyeff. Submitting to a closer investigation those solutions which are accompanied by a lowering of temperature, the author comes to the conclusion that such is the case for those liquids which have not a chemical affinity, and that those are true solutions; while in those cases where a rise of temperature is noticed, the dissolved liquid enters into chemical combination with the dissolving one. He makes a series of very interesting experiments in order to determine the thermal effects of various solutions.—On the relations between the chemical composition and the refractive power of chemical compounds, by J. Kanonnikoff (second paper).—On the structure of nitro-compounds of the saturated series, by J. Kissel.—On the composition of the mineral waters of Caucasus, by J. Barsilovsky.—On the structure of the blue indigo, by P. Alexeyeff.—On the action of alkalies on chondrine, by M. Schwarz.—On the azocuminic acid, by P. Alexeyeff (first paper).—On chemical affinity, by A. Bazaroff.—Analysis of the epidermis attacked by the *Prosyarsis rubra*, by K. Wagner.—On the preparation of pure albumin, and on the determination of chlorine in urine, by W. Mikhailoff.—On the structure of the atmosphere and on the general laws of the theory of gases, by E. Rogovsky. The strong mathematical inquiry of the author brings him to the following conclusions:—However the atmosphere has no limits, but at a height of 1000 km. the density of air is very near to zero; its constitution varies with the height, the content of oxygen decreasing as the height increases; this change is very slow for heights less than 10,000 m., still it might be ascertained by accurate measurements; for heights less than 10,000 m. the density of air can be calculated as if it were a simple gas; the decrease of density with the height goes on slower when the temperature at the surface of the earth is higher. The paper has to be continued.—On the theory of measurements, by N. Sloughinoff.—On galvanic batteries, by P. Novikoff.

Rivista Scientifico-Industriale, March 31 and April 15.—Electric currents through contact with earth, by Prof. A. Volta.—Experiments with electrified paper, by D. Surdi.—Variations in the electric resistance of solid and pure metallic wires, with variations of temperature, by Prof. Angelo Emo.—On the Gauthier and Walrand methods of distinguishing steel from iron, by the editor.—Note on two hybrids of *Anas boschas* and *Dafila acuta*, by Dante Roster.

Rendiconti del R. Istituto Lombardo, April 3 and 17.—Programme of prize essays in various departments of Science, Art, and Letters proposed for the years 1884–91.—The Castle of Milan, its historic and artistic associations, by Prof. Giuseppe Mongeri.—On some unpublished fragments of Anatolius's Greek version of the "Codex Justinianus," by Dr. C. Ferrini.—Note on Virgil and his Italian imitator, Parini, by Prof. Cr. Fabris.—On Antonio Angeloni Barbiani and his literary productions, by E. B. Prina.—Analysis of the mineral waters of Acquarossa, Canton of Ticino, by Prof. G. Bertoni.—Malformations in the urinary ducts in Bright's disease, by Prof. C. Golgi.—Meteorological observations made at the Brera Observatory, Milan, during the month of March.

SOCIETIES AND ACADEMIES

London

Royal Society, May 1.—"Report to the Solar Physics Committee on a Comparison between Apparent Inequalities of Short Period in Sun-spot Areas and in Diurnal Temperature Ranges at Toronto and at Kew." By Balfour Stewart, M.A., LL.D., F.R.S., and William Lant Carpenter, B.A., B.Sc. Communicated to the Royal Society at the request of the Solar Physics Committee.

It has been known for some time that there is a close connection between the inequalities in the state of the sun's surface as denoted by sun-spot areas and those in terrestrial magnetism as denoted by the diurnal ranges of oscillation of the declination magnet; and moreover the observations of various meteorologists have induced us to suspect that there may likewise be a connection between solar inequalities and those in terrestrial meteorology.

This latter connection, however (assuming it to exist), is not so well established as the former, at least if we compare together inequalities of long period. It has been attempted to explain this by imagining that for long periods the state of the atmosphere as regards absorption may change in such a manner as to cloak or diminish the effects of solar variation by increasing absorption when the sun is strongest, and diminishing absorption when the sun is weakest.

On this account it seemed desirable to the authors to make a comparison of this kind between short-period inequalities, since for these the length of period could not so easily be deemed sufficient to produce a great alteration of the above nature in the state of the atmosphere.

The meteorological element selected for comparison with sun-spots was the diurnal range of atmospheric temperature, an element which presents in its variations a very strong analogy to diurnal declination-ranges.

There are two ways in which a comparison may be made between solar and terrestrial inequalities. We may take each individual oscillation in sun-spot areas, and find the value of the terrestrial element corresponding in time to the maximum and the minimum of the solar wave. If we were to perform this operation for every individual solar inequality, and add together the results, we might probably find that the magnetic declination range was largest when there were most sun-spots. If, however, we were to make a similar comparison between sun-spot daily areas and diurnal temperature-ranges we might not obtain a decisive result. For at certain stations, such as Toronto, it is suspected (the verification or disproval of this suspicion being one of the objects of this paper) that there are two maxima and two minima of temperature-range for one of sun-spots. The effect of this might be that in such a comparison the temperature-range corresponding to a maximum of sun-spots might be equal in value to that corresponding to a minimum, or, in other words, we should get no apparent result, while, however, by some other process proofs of a real connection might be obtained. But if we can get evidences of apparent periodicity in sun-spot fluctuations when dealt with in a particular manner, we have at once a method which will afford us a definite means of comparison. And here, as Prof. Stokes has pointed out, it is not necessary for our present purpose to discuss the question whether these sun-spot inequalities have a *real* or only an *apparent* periodicity. All that is needful is to treat the terrestrial phenomena in a similar manner, or in a manner as nearly similar as the observations will allow, and then see whether they also exhibit periodicities (apparent or real) having virtually the same times as those of sun-spots, the phases of the two sets of phenomena being likewise allied to one another in a constant manner.

It is such a comparison that the authors have made, their method of analysis being one which enables them to detect the existence of unknown inequalities having apparent periodicity in a mass of observations. A description of this method has already been published in the *Proceedings of the Royal Society* for May 15, 1879. The comparison was made by this method between sun-spot observations extending from 1832 to 1867 inclusive, Toronto temperature-range observations extending from 1844 to 1879 inclusive, and Kew temperature-range observations extending from 1856 to 1879 exclusive. The following conclusions were obtained from this comparison :—

1. Sun-spot inequalities around twenty-four and twenty-six days, whether apparent or real, seem to have periods very nearly the same as those of terrestrial meteorological inequalities as exhibited by the daily temperature-ranges at Toronto and at Kew.

2. While the sun-spots and the Kew temperature-range inequalities present evidence of a single oscillation, the corresponding Toronto temperature-range inequalities present evidence of a double oscillation.

3. Setting the celestial and terrestrial members of each individual inequality, so as to start together from the same absolute time, it is found that the solar maximum occurs about eight or nine days after one of the Toronto maxima, and the Kew temperature-range maximum about seven days after the same Toronto maximum.

4. The proportional oscillation exhibited by the temperature-range inequalities is much less than the proportional oscillation exhibited by the corresponding solar inequalities.

Chemical Society, May 15.—Dr. Perkin, F.R.S., president, in the chair.—The following papers were read :—On refraction equivalents of organic compounds, by Dr. J. H. Gladstone. In this paper is given a series of tables embodying the results of observations made from time to time since 1870. In these tables the refraction equivalents for the line A for about 140 substances are given and compared with the refraction equivalents calculated from the following values of the respective elements :—Carbon (saturated) 5·0, carbon in C_nH_n 5·95, carbon double-linked 6·1, hydrogen 1·3, oxygen single bond 2·8, oxygen double bond 3·4, nitrogen 4·1, nitrogen in bases, NO_2, &c., 5·1, chlorine 9·9, bromine 15·3, iodine 24·5, sulphur single bond 14·1, sulphur double bonds 16·0.—On the estimation of silicon in iron and steel, by T. Turner. The author has compared the various methods of analysis, and concludes that the chlorine process suggested by Watts, with certain modifications, is applicable to all classes of iron, and is on the whole the best.—Note on the melting-points and their relation to the solubility of hydrated salts by Dr. W. A. Tilden.—Note on ferric sulphocyanate, by A. J. Shilton. The author finds that a large excess of potassium sulphocyanide or of boiling hydrochloric acid interferes with the well-known blood-red colour given by ferric salts and a sulphocyanide.—A memoir detailing some minor researches on the action of ferrrous sulphate on plant life, by Dr. Griffiths. The author finds that 0·15 per cent. of ferrous sulphate added to a solution of various salts aids, whilst 0·2 per cent. is fatal to, the development of mustard seeds and cabbage plants.

Physical Society, May 10.—The meeting was held in the chemical theatre of the Mason College, Birmingham. Members had previously visited some of the factories in the town, including Gillott's pen works.—Dr. Guthrie, president, took the chair at three p.m., when Prof. J. H. Poynting made a communication on an experiment illustrating the refraction of water-waves. The experiment was designed to illustrate by means of waves in water the refraction of waves when they pass from one medium to another in which their velocity is different. The apparatus consisted of a tank 2 feet 6 inches square, with a plate-glass bottom. Water is poured into the tank to a depth of say 5 to 6 mm. The lid of the tank consists of a calico screen, and is slightly tilted up. A limelight under the tank projects the wave on a screen. Plates of glass 3 or 4 mm. thick are placed in the tank, thus reducing the depth of water. If waves are sent across the tank they travel more slowly through the shallow water, and are seen to be refracted. When circular or lenticular plates are used, the refracted waves are seen to converge to a focus.—Mr. C. J. Woodward exhibited an oxy-hydrogen lantern suitable for lecture purposes.—Dr. Gladstone took the chair, and Prof. Guthrie, president, exhibited a sealed tube containing 46·6 of tri-ethylamine, and 53·4 of water. At temperatures between 0° C. and 18·3° C. the liquid forms a clear mixture. At 18·3° it becomes turbid, and at 26° C. almost perfect separation is effected. It was stated that all proportions of the two liquids containing about 15 per cent. and 50 per cent. of triethyl amine become turbid at the same temperature. A mixture containing 4 per cent. requires a temperature of 41° C. to produce turbidity, while one containing 90 per cent. is turbid at 6° C. A series of sealed glass bulbs containing the liquids in different proportions can be employed to indicate the fever temperature of the body if placed under the tongue. The author also showed the connection between such separation by heat and the separation between the same two bodies by cold, whereby in the latter case, according to the strength of the solution, either ice or subcryohydrate is separated, until the composition and temperature of the cryohydrate is reached (19·2 per cent. ; – 3·8° C). The peculiar white condensed vapour of the chloride of triethylammonium was exhibited. The white fume of this body so quickly aggregates into masses, that the shapes of the smoke-lines and curls are preserved. Dr. Gladstone agreed with the author in supposing that the separation of triethylamine and water was continuous in nature with the separation of ammonia from water by heat. Dr. Tilden exhibited a tube containing a cold, clear solution of amylic alcohol in water which became turbid on gently warming, and clear again on heating to about 60° C. He suggested that a similar remixing might take place with ethylamine and water. Prof. Silvanus P. Thompson recalled the experiments of Prof. Ramsay on the critical state described by Andrews, and the failure of a body beyond the critical condition to retain in solution the substances it held as a liquid. Mr. W. Lant Carpenter suggested the microscopic examination of the triethylamine and water mixture at its critical temperature.—Members then visited the College rooms.

Royal Microscopical Society, May 14.—Rev. W. H. Dallinger, F.R.S., president, in the chair.—A resolution was passed altering the by-laws so as to make ladies eligible as Fellows of the Society, but without the right of attending ordinary meetings.—Dr. Golding Bird exhibited a new freezing microtome of his construction, adapted for students and intermittent workers, and for use with ice and salt, or with ether.—Mr. Boecker showed an extensive series of Bacteria, Bacilli, and other Schizomycetes.—A very curious microscope of the date of 1772 was exhibited by Mr. Crisp, in which, with other peculiarities, three objectives were attached to a sliding plate at the end of the nosepiece in a way similar to that adopted in the modern Harley and other microscopes. Also two microscopes by Reichert of Vienna, one with a very simple form of Abbe condenser, and the other with a polarising prism attached to a swinging and rotating diaphragm.—The following apparatus and objects were also exhibited and discussed :—Frog plate made of glass, with serrated edges for the string ; Griffiths' multiple eyepiece (an attempt to combine four eyepieces in one by fixing different eye-lenses in a rotating disk) ; Bradley's "mailing boxes" for sending one or several slides conveniently by post; Dancer's objects found in flue-dust and coal-ash; Stokes' minnow-trough; B. W. Thomas's Foraminifera obtained by washing clay from the boulder drift in Minnesota, showing forms identical with some now found living in the Atlantic Ocean; some exceptionally well mounted slides of arranged Diatoms by R. Getschmann of Berlin; some curious Schizomycetes by Mr. Cheshire, and a rotalian from closed flint nodular cavity metamorphosed into chalcedony, by Dr. G. C. Wallich.—Dr. P. H. Carpenter gave an account of his views respecting the nervous system of the Crinoidea, and exhibited some preparations in illustration of them. He directed attention more particularly to the branches from the axial cords of the skeleton, which extend upwards into the ventral perisome at the sides of the ambulacra, both of the arms and of the disk.—The President, Mr. Glaisher, vice-president, and Mr. A. W. Bennett, a member of the Council, were appointed a deputation for the Society, to attend the annual meeting of the American Society of Microscopists at Rochester, N.Y., U.S.A., on August 19 next.

Royal Meteorological Society, May 21.—R. H. Scott, F.R.S., president, in the chair.—Capt. W. W. Hampton and C. D. F. Phillips, M.D., F.R.C.S., F.R.S.E., were elected Fellows of the Society.—The following papers were read:—Notes on the proceedings of the International Polar Conference held at Vienna, April 17 to 24, 1884, by R. H. Scott, F.R.S., president.—Meteorological observations on the Maloja Plateau, Upper Engadine, 6000 feet above the sea, by Dr. A. T. Wise. The Maloja Plateau is situated at the higher extremity of the Upper Engadine, and is protected from northerly, easterly, and southerly winds. The author gives some account of the meteorology of this plateau, and also the observations made during the four months from November 1883 to February 1884.—On some results of an examination of the barometric variations in Western India, by A. N. Pearson.—Illustrations of the mode of taking meteorological averages by the method of weighing paper diagrams, by R. Inwards, F.R.A.S.—Ten years' weather in the Midlands, by Rupert T. Smith.

EDINBURGH

Royal Society, May 5.—Mr. Robert Gray in the chair.—Dr. Sang gave a paper on the formulæ for computing logarithmic sines.—Mr. J. Murray communicated a paper, by Mr. J. T. Cunningham, on a new Trematode.—Mr. George Seton read a paper on the vital statistics of Scotland; and Prof. Turner gave a communication, by Mr. A. Wynter Blyth, on the results of experiments made by him on the chief disinfectants of commerce. His object in experimenting was to discover their efficiency in destroying the spores of *Anthrax bacillus*.

May 19.—Mr. Robert Gray, vice-president, in the chair.—Prof. Chrystal communicated a note, by M. Hermite, "Sur la Reduction des Intégrales Hyperelliptiques."—Prof. Schuster, at the request of the Council of the Society, gave an address on the discharge of electricity through gases. His address was illustrated by several beautiful experiments.

PARIS

Academy of Sciences, May 19.—M. Rolland, president, in the chair.—Note on a theorem of M. A. Lindstedt concerning the problem of the three bodies, by M. F. Tisserand.—On bromic substitutions, by MM. Berthelot and Werner.—Kinematic analysis of the action of walking in man (four illustrations), by M. Marey.—Note on the twenty-three first sheets of the map of Africa to the scale of 1 : 2,000,000, presented by Col. Perrier to the Academy, by M. F. Perrier. The map, which is mainly the work of Capt. de Lannoy, will consist altogether of sixty-two sheets, and is expected to be completed towards the end of 1887.—Pathological experiments on rabies, by M. Pasteur, assisted by MM. Chamberland and Roux.—Note on the attenuation of cultivated virus treated with compressed oxygen, by M. A. Chauveau.—Note on the transformation of conicine to propylpyridine; regeneration of conicine, by M. A. W. Hofmann.—Observations on the new planet 236 (discovered at Vienna, by M. J. Palisa, on April 26, 1884), made at the Paris Observatory (equatorial of the west tower), by M. G. Bigourdan.—Determination of the elements of rotation of the sun, by M. Spörer.—Properties of nine points of a left curve of the fourth order, of seven points of a left cubic, of eight associated points, by M. A. Petot.—On a linear equation of the third order analogous to Lamé's equation, by M. E. Goursat.—Remarks relative to the velocity of propagation of the wave produced in the Indian Ocean by the Krakatoa eruption, by M. Boussinesq.—Adoption by the Vienna International Polar Conference of new absolute magnetic unities (centimetre, gramme, second), by M. Mascart.—New method of measuring the intensity of an electric current in absolute unities, by M. Henri Becquerel.—Note on a new mercurial galvanometer, by M. G. Lippmann.—On the variations of the physical properties of bismuth placed in a magnetic field, by M. Hurion.—On the coefficients of expansion in the elementary gases, by M. J. M. Crafts.—On the various theoretic results that have to be considered in steam engines, by M. P. Charpentier.—On the transmission of sound by gases, by M. Neyreneuf.—Note on the variation of the indices of refraction of quartz under the influence of temperature, by M. H. Dufet.—On the determination of the densities of vapour by gaseous displacement under reduced and variable pressure, by M. J. Meunier.—Action of the sulphuret of potassium on the sulphuret of mercury, by M. Debray.—On the acid phosphates of baryta, by M. A. Joly.—On the solubility of salts, by M. Etard.—Note on crystallised chloride of ammoniacal silver and iodide of ammoniacal silver, by M. Terreil.—On an artificial pseudomorphosis of silica, by M. A. Gorgeu.—Analysis of the mineral waters of Brucourt, Calvados (Normandy), by M. Vulpian.—On the employment of superphosphates in agriculture; observations in connection with a recent note of M. Lechartier, by M. P. P. Dehérain.—Comparative nitrifying action of some salts either naturally contained in or superadded to vegetable soils, by M. P. Pichard.—A new series of experiments on the differential perception of colours, by M. Aug. Charpentier.—Note on the brain of *Eunice harassii* and its relations to the hypoderm, by M. Et. Jourdan.—On the genus Rhopalea (simple Ascidians), by M. L. Roule.—On the presence of the Egyptian Naja (*Naja haje*, Dumer.) in Tunis, by M. Valery Mayet.—Pretended influence of light on the anatomic structure of the leaves of *Allium ursinum*, by M. Ch. Musset.—Remarks on a hypsometric map of Russia, by General de Tillo.—On the remarkable solar halo recently observed at Palermo, by M. A. Ricco.—Fresh observations on the crepuscular lights seen in the Isle of Bourbon, by M. Pelagaud.

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