THURSDAY, MARCH 13, 1879

THE UNITED STATES FISHERIES

United States Commission of Fish and Fisheries—Report of the Commissioner for 1875-76. (Washington: Government Printing Office, 1878.)

THE series of volumes now being issued by Mr. Spencer Baird, Fishery Commissioner of the United States, of which the fourth has just reached us, is in every way remarkable. As a much required contribution to our scanty knowledge of fishery economy and the natural history of American food fishes, it presents a mass of very valuable information; the details incidental to the propagation of carp and salmon are particularly interesting, not only because they show the gigantic scale on which these things are done on the other side of the Atlantic, but also because of what they teach as to the mode of doing them. The historic and economic sketches of the fish and fisheries of various other nations are likewise full of interest, Mr. Baird having allowed nothing to escape which he thinks will illustrate his subject or render testimony to the value of the work in which he is engaged.

The contents of the present volume, if not so varied as those of some of its predecessors—over 750 of its pages being devoted to a historical account of the American whale fishery—are certainly not less interesting. There is a report on the fisheries of Chicago and vicinity, which, we are told, yield annually about 12,000,000 lbs. weight of fish; there is also an article on the condition of the salmon fisheries of the Columbia River, from which we have recently been receiving enormous consignments of canned salmon; the present volume likewise contains notes on the fishes of the Delaware, together with an abundant supply of information regarding the propagation of various of the minor food fishes of America.

We are not in the least surprised to learn that a diminution of the supplies of Columbia River salmon (*Salmo quinnat*) has taken place. These fish, consequent on being free to all who choose to capture them, have given constant employment to about fifteen "canneries" during ten or twelve years, each of which, if we strike an average, will turn out a million pounds weight of fish per annum. There are various kinds of salmon in the Columbia River, but there seems to be some confusion regarding their proper identification; that we have mentioned is the one which is captured for the canneries. It will probably be found on further investigation that one or two of the so-called varieties are simply the same fish in different stages, as in the case of *Salmo salar* and the "grilse;" fish of all sizes being, we are told, found together in the Columbia and its tributaries. It is rather singular that no very large salmon are found in that great stream. Mr. Livingstone Stone who reports to the Commission on the subject, says that the largest salmon he ever saw had a girth of 31 inches, and was 35 inches in length and weighed 65½ lbs. One which was *said* to have weighed 83 lbs. was reported to Mr. Stone by a fisherman who saw it. The average weight of the Columbia salmon (*Salmo quinnat*) is from 22 to 23lbs. whole, but when dressed for market only about 17lbs. The ratio of salmon growth has never been accurately determined. Some large salmon (*Salmo salar*) are captured in the salmon streams of Scotland, but the age of such fish cannot be set down with any certainty. In a report made by Mr. Stone given in a previous volume of Mr. Spencer Baird's reports (1872-73) regarding the Sacramento salmon, it is mentioned as a "theory" that salmon are full-grown at the age of about three years. We commend this question of salmon growth to the farther notice of Mr. Commissioner Baird. In the United Kingdom the evidence obtained on this point has hitherto been of the most contradictory nature. Our own opinion is that salmon are never "full grown," or rather that as long as they are alive they continue, under proper conditions of food and living room, to increase in weight and size. After much weighing of evidence we recently came to the conclusion that a fish which we handled in August last (1878), and which weighed 54 lbs., was at least nine or perhaps ten years old. From some inquiries which we are making, we hope to be provided with sufficient data for a settlement of the question during next fishing season. Returning for a moment to *Salmo quinnat*, the following notice of the periods and strength of its migration may be useful for comparison with the habits of *Salmo salar*:—"The salmon make their first appearance in February, though in very small numbers; the main body arrives in May, June, and especially in July, when the run is enormous. The May salmon are largest. Perhaps the most correct view to take of the running of the salmon is to consider all the salmon as included in one run, beginning in February, increasing in May and June, and culminating in July, though they might also be legitimately divided into three runs, the first or meagre run coming in February, March, and April, the second or full run in May and June, and the third or maximum run in July. After July they diminish very rapidly, and soon almost entirely disappear from the river."

It is at present being considered, we believe, whether or not it will be necessary to resort to "pisciculture" on the Columbia river. Would it not be better to limit for a time the spoliation of the water? At present no check whatever is placed on the fishery, and each "cannery" captures and tins all the salmon that it can find, and with each establishment working up a million pounds' weight per annum, the complete exhaustion of the supply is only a work of time, as has been demonstrated in our own rivers.

The artificial hatching of salmon is conducted in the United States on quite a gigantic scale. A table is given in the report of "operations on the McCloud river in 1876," from which we learn that on one day, Sept. 4, over a million salmon eggs were obtained by a process of artificial spawning. During the years 1874-75 and 1876, the number of ova taken for despatch to different rivers was 21,877,300. In 1875, 8,629,300 eggs were secured, which, at the British rate of a thousand eggs for each pound of salmon weight, represents the handling of a large number of fish. The cost of collecting the spawn is about four shillings per thousand. The eggs taken in the McCloud river are widely distributed, some being sent to Canada and a portion to New Zealand.

Much valuable information is given in the present series of reports on the best modes of salmon hatching, and the

careful observations of temperature made during the manipulation are tabulated for future use. With reference to *Salmo quinnat* of the Sacramento, it may be confidently affirmed that there is almost no difference between it and *Salmo salar*, which, in form and habits, it closely resembles; it has, however, if we mistake not, more rays in the anal fin, and is of course able to endure a higher temperature: the eggs mature in summer and hatch in the autumn. In ascending to their spawning grounds the *gravid* fish must frequently pass through river water having a temperature of over 76°. We were not prepared for the following remarkable statement from New Zealand, made in the present volume (p. 989):—"*So far as yet observed, the adult fish all die after spawning, and never return to the sea.*" This fact is stated in a "memorandum respecting the American salmon and white fish recently introduced in New Zealand by Dr. James Hector, of the Colonial Museum, Wellington." We shall be glad to have some authoritative statement with regard to the above fact, as without some explanation it seems too extraordinary for belief.

An interesting account of the distribution and habits of the "Shoodic salmon" is given in the present volume. These fish, *Salmo sebago*, are known as "land-locked salmon," at one time probably in communication with the sea, but now shut out from it altogether, and thus forced to pass their lives in fresh water for ever. There is, however, no evidence that "the supposed change of habits—the abandonment of the seaward migrations—came about in such a way as the term, *land-locked*, implies." Mr. Atkins, in his report to the commissioner, makes a statement which we should like to have explained. In collecting the spawn of the "Shoodic salmon," there was taken, he says, a single female specimen of *Salmo salar*; "she yielded 10,000 eggs, which were impregnated with the melt of the 'Shoodic salmon;' they developed well, and hatched into vigorous fish." But how did a female specimen of *Salmo salar* come to be among the "land-locked" fish? and what became of her?

The operations of the United States Fish Commission commenced eight years ago, and are still being prosecuted. The work has been varied, as we have indicated, and, so far, it has been well done, and the information accumulated will form a quarry which will yield a lasting supply of fishery knowledge to all inquirers.

THE PACIFIC ISLANDS

Reise durch den Stillen Ocean. Von Max Buchner. (Breslau: J. U. Kern, 1878.)

THE author of this pleasantly written and very interesting book of travel became, as he tells us, a ship's medical officer, in order to gratify his desire to see the world. He sailed in an emigrant ship from Hamburg to New Zealand and returned home by Fiji, the Sandwich Islands, San Francisco, and the Pacific railroads. He made a considerable stay at New Zealand, Fiji, and the Sandwich Islands, and the chief interest of his book lies in the accounts of what he saw at these places. Though there is little new information in the work the descriptions are extremely good.

On board the emigrant ship there devolved on him not only the usual medical work but also the entire charge and government of the 397 emigrants and the division of rations amongst them. He draws a very unpleasant picture of the dangers and sufferings incurred by passengers in such a vessel. The captain seems to have known little of his business. After a narrow escape of collision the ship appears to have incurred a still narrower risk of running on the Goodwin Sands, and on the open ocean there seems to have been constant doubt as to longitude. A terrible picture is drawn of the sufferings of the emigrants—a mixture of Poles, Scandinavians, Germans, and Dutch—in a storm. The captain, who in such voyages receives a small percentage on the profits of the voyage from the owners of the ship, made constant attempts to cut short the allowance of food to the passengers. The author, who acted in the interests of the New Zealand Government and their emigrants, had great difficulty in making the captain, who cursed and swore and hammered the table with his fist when appealed to, act up to the details of the contract in the matter of rations. Even then the food seems to have been insufficient, and the salt beef was constantly being stolen, the beef tub being forcibly broken open for the purpose. The barbarous old custom of shaving on crossing the line was carried out, but we are glad to find that only volunteers amongst the emigrants were operated on. An outbreak of typhoid fever occurred on board before New Zealand was reached and caused nine deaths.

The author gives a most interesting and lively account of the present condition of the Maoris. At Lake Taupo there is now a very good clean hotel kept by a German and an Italian; and a Maori, who goes by the name of Mr. Jack, has established himself as guide of Taupo. He has constructed a bathing-place at the hot springs with a room over the bath and dressing-room, and charges a shilling for each bath. Close by, but hidden in the vegetation, our author discovered an equally good or better natural hot bathing-place, but the crafty Maori had filled it with dirt for fear it should compete with his own. At Ohinemotu on the south shore of Lake Rotorua, where are the principal hot springs, there are two good hotels for tourists and a population of about 300 Maoris. Every evening the greater part of the population turn out and bathe together in a small bay of the lake which is kept constantly warm by the hot springs, and whites and browns of both sexes swim about and sit in the warm mud together, conversing for hours at a time. Close by the bathing-place are a group of huts, the owners of which are dead, and which are tabu, and are described as full of ancient native implements, spears, adzes, wood-carvings, and other desiderata for ethnological museums, but which no one dares to touch. A performance of the "haka," the old New Zealand dance, was got up for the author and his friends, on their paying a sovereign a-piece, but the young Maoris seem not to care for the dance any longer, and to perform it only for the benefit of tourists for money, and the performance lacked spirit, and soon came to an end. The hula, hula, in the Sandwich Islands, seems to be dying out in the same manner, and in Tahiti, when the old lascivious dances are performed, they are usually got up for the benefit of European visitors, through the agency of the native washermen, who combine such offices with their legitimate business. The young Polynesians in New Zealand, as elsewhere, prefer the waltz

and other European dances. The author enjoyed himself so much in Ohinemotu that he spent all his money and had to travel to Tauranga on foot. Here he saw the ceremony of nose-rubbing performed with great solemnity; it is, however, now kept up almost only by the old; the young Maoris have taken to kissing as a substitute. There is still a wide tract of the northern island of New Zealand 1,000,000 acres in extent, known as King Country, inhabited by about 10,000 Maoris under King Tawhiao, who keep themselves free from British rule, and do not permit whites to enter their country. King Country seems to be a thorn in the side of the Government, and the city of refuge of murderers and thieves, who are there out of harm's way.

At the Fiji group, the author visited only one island, that of Kandavu, at which the mail steamers call. He, however, explored a great deal of this island, in company with the natural history collector employed by Goddefroy Brothers, Herr Kleinschmidt, who is laboriously exhausting the fauna of the Fiji group, collecting carefully for several months in each island. The author's account of Kandavu, and especially of the natives, is full of interest. One of his observations may be cited here. A Fijian youth, employed as an assistant in collecting, whose body was already beautified by many cicatrisations, was devoting his attention to two groups of small suppurating wounds on the outer side of each upper arm. When visitors from neighbouring villages were present, he used to open these wounds anew and inflame them with a burning stick, or sand, or by scratching them with glass, in order to show his fortitude, never moving a muscle of his face in public, but making very wry faces afterwards in private. Many other youths had similar wounds on their upper arms, and it turned out that vaccination was being carried out by the Government in Kandavu, village by village, and that pustules on the upper arm were hence the fashion. The dandies would not wait till the turn of their village arrived, or perhaps the natives wished to avoid the actual operation by giving their arms the appearance of having been already vaccinated.

The author very rightly denounces the absurd method of spelling the Fijian language introduced by the missionaries. Because, in Fijian words, before the sounds *d g k* and *m*, an *n* nearly always is sounded, and before *b*, an *m*, the missionaries in first writing the language chose to omit the *m* and *n* in all cases in spelling before these letters, which complicates matters unnecessarily, and must eventually give great trouble to Fijians when they come to read English. Thus Thakombau, the name of the former king of Fiji, is spelt Thakobau. Kandavu is spelt Kadavu. Some writers have carried useless confusion still further, and have rendered *th* by *c*, so that Thakombau becomes Cacobau, and so it was most often spelt in newspapers at the time of the annexation of Fiji, so that English readers derived very little impression of the real sound of the name.

The author proceeded to Honolulu by Pacific mail steamer. Amongst the passengers was a San Francisco concert company and a reverend Yankee travelling lecturer. The concert company hoped to give a performance on the day on which the steamer stopped at Honolulu on its way to San Francisco, but the lecturer had been too sharp for them, and had engaged the only available hall long beforehand, and they found the town posted all over with advertisements of his lecture on the Tower of London. The author visited Hilo, in Hawaii, and the volcano of Kilauea. He returned from Hawaii to Honolulu in an open whale-boat, touching at the island of Maui on the way, an exploit which seems to have astonished the people of Honolulu extremely, since they have come to rely upon schooners and steamboats entirely for such long passages, and no longer make the voyage, as of yore, in war canoes. The author's account of San Francisco and its Chinese quarter is hardly so interesting as the earlier part of the book, as this quarter has been done to death in so many books of travel, and after all Chinese life at San Francisco is in all essentials identical with Chinese life at home. Perhaps before many years we shall have a Chinese quarter in London.

The official account of the Pacific railroads, sold on the line, "Williams' Pacific Tourist," which is got up in the interests of the railroad companies, is very properly denounced by the author. It is, indeed a shameless puff of the supposed beauties of the scenery on the line of the railroad, which exist for the most part only on paper and in the fervent imagination of the writer. An account of Salt Lake City and Niagara close Dr. Max Buchner's very pleasant volume. Some passages in the book are rather free in their tone; a case of midwifery on board ship is described with needless detail; many of the doings of Polynesians are also described with little reserve.

OUR BOOK SHELF

Index Medicus. A Monthly Classified Record of the Medical Literature of the World. Compiled under the Supervision of Dr. John S. Billings, Surgeon U.S. Army, and Dr. Robert Fletcher, M.R.C.S. Eng. (New York, F. Leypoldt; London, Trübner and Co.)

FOR some time back Dr. Billings, of the United States Army, has been engaged in the preparation of an Index-Catalogue of the library of the surgeon-general's office at Washington. To those who do not understand what this work is, this may not seem to be at all extraordinary, but those who know that the work is really an universal catalogue of medical literature, giving not only the names of the authors, but the subjects of the papers which have appeared in all medical periodicals throughout the world from the time of their first issue until the present, will be astonished that any man has had the courage to undertake such a task, and still more to learn that the MS. of this catalogue is now nearly ready for press, and is only awaiting the authority of Congress to print it. For the sake of medicine throughout the world we trust that this authority will be granted without delay, for to every man who has the interests of medicine at heart this work will be an invaluable boon. It has been suggested that such a catalogue should be supplemented by some current publication, which should show all recent works, together with articles and periodicals arranged by subjects, and the present publication has been issued to supply this want.

"In its pages the practitioner will find tables of parallels for his anomalous cases, accounts of new remedies, and the latest methods in therapeutics. The teacher will observe what is being written or taught by the masters of his art in all countries. The author will be enabled to add the latest views and cases to his forthcoming work, or to discover where he has been anticipated by other writers; and the publishers of medical books and periodicals must necessarily profit by the publicity given to their productions.'

Dr. Billings very sensibly suggests that all medical men who approve of the objects of this Index, will put their approval into practical shape by subscribing promptly for the Index and taking care that a copy of every book, pamphlet, &c., of which they are the authors, is forwarded to the editors. This recommendation we heartily endorse, and trust that so useful a publication may receive the support it deserves.

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 ensure the appearance even of communications containing interesting and novel facts.*]

The Tides at Chepstow and Fundy

In NATURE, vol. xix. p. 363, Mr. Moseley, of Exeter College, Oxford, quotes a passage from Lyell's Principles, to the effect that the tides at Chepstow have a range of 72 feet.

This statement is continued in the last edition (1875), in Chap. XX., on Tides and Currents, p. 492; and the tidal range in the Bay of Fundy is set down at 70 feet (p. 564). I do not believe either of the statements.

The Admiralty Tide Tables give the following:—

	Spring Range. Feet.	Neap Range. Feet.
1. Chepstow	38	28·5
2. Bay of Fundy (Noel Bay) ...	50·5	43·5

I may add that Lyell's whole treatment of the subject of the tides is loose and inaccurate. Thus, for example, he says (p. 491): "In any given line of coast the tides are greatest in narrow channels, bays, and estuaries, and least in the intervening tracts where the land is prominent."

He then proceeds to illustrate this proposition by giving the ranges of tide from the mouth of the Thames to Flamborough Head (including, of course, the well-known *tidal node of minimum range* off Yarmouth); but he is utterly unconscious that these ranges depend altogether on the tidal motion of the water, and have no relation whatever to the form of the coast.

Trinity College, Dublin, March 3 SAML. HAUGHTON

Magnetic Storms

IT is surprising that an accomplished telegraphist like Mr. Mance (NATURE, vol. xix. p. 409) should not see the necessity and advantage of expressing earth-currents in webers. It is precisely because every one can, if he likes, appreciate the magnitude of an earth-current so expressed, and no one but himself can do so if Mr. Mance's plan were adopted, that I advocate the weber, or rather, its more convenient sub-multiple, the *milliweber*. A milliweber is the current produced by one Daniell's cell (strictly one volt), through 1,000 ohms. Currents can be reduced to this unit from any galvanometer. The tangent galvanometer is, perhaps, the simplest to use—it is that which we employ in England. Supposing for simplicity that your constant, viz., one Daniell cell through 1,000 ohms (including cell and galvanometer) gives 45°, then the tangent of any other reading will give you the current in milliwebers. Then, knowing the resistance of your circuit and its geographical position, you have all the data necessary to determine the elements of earth-currents.

I will act on Mr. Mance's suggestion, and bring the matter before the Society of Telegraph Engineers with a view of organising a systematic mode of observation in different parts of the world. W. H. PREECE

Wimbledon, March 8

Atmospheric Pressure and Solar Heat

MAY I be permitted to supplement the table given by Mr. Allan Broun in NATURE, vol. xix. p. 7, by the following figures for Calcutta. The pressure anomaly at Bombay for each year, as given by Mr. Broun, is here compared with Calcutta, and the table is extended down to 1877:—

Table Showing Difference of Mean Pressures at Calcutta as Compared with Bombay for the whole Year and the Summer Months, the Sign + Indicating an Excess at Calcutta, and − a Defect; and Character of the Rainfall in the North-West Provinces and Behar.

Year.	Year.	Summer.	—
1847	−37	+ 5	Excessive.
1848	+ 7	−13	Defective.
1849	+14	+ 5	Excessive.
1850	+21	+ 5	Average.
1851	+ 8	+11	Excessive.
1852	+16	+18	,,
1853	−19	−31	Defective.
1854	+ 1	− 2	Excessive.
1855	−10	−30	Defective.
1856	− 2	− 1	Average.
1857	− 9	−10	Defective.
1858	− 3	− 9	,,
1859	+ 8	+26	Excessive.
1860	−15	−13	Defective.
1861	−12	− 3	Average.
1862	+12	+15	Excessive.
1863	− 7	−16	Defective.
1864	−14	−27	,,
1865	+15	+13	Excessive.
1866	−10	−20	Defective.
1867	+ 5	+ 4	Average.
1868	− 6	−13	Defective.
1869	+ 1	+ 5	Excessive.
1870	+ 3	+ 4	,,
1871	−37	− 3	,,
1872	+13	+18	,,
1873	+ 3?	−11	Defective.
1874	+ 5?	+24	Excessive.
1875	−15	− 2	Average.
1876	−24	− 5	Defective.
1877	+14?	+ 3	,,

Since from 1847 to 1852 there are frequent blanks in the registers, sometimes exceeding ten days in length, the figures are of somewhat doubtful value.

It will be seen on examination that the decennial period is nearly as distinctly marked at Calcutta as at Bombay, though the minor fluctuations are more frequent, and that, as Mr. Chambers supposed, the amplitude of the anomaly, like that of the diurnal and annual variation, is greater at Calcutta than at Bombay.

Mr. Broun considers the discovery of the decennial period of barometric pressure to be one of great importance, as forming a link in the chain of evidence which connects the variations of rainfall with those of the sun's heat. As an illustration of the way in which the variations of pressure influence the distribution of rainfall, I have entered a word descriptive of the character of the rainfall of each year in the North-West Provinces and Behar. In the great majority of cases a relatively low pressure at Calcutta, especially during the summer months, April to September, means defective rainfall over the valley of the Ganges, which is watered by easterly winds from the Bay of Bengal, and a relatively high pressure at Calcutta means excessive rainfall. Had the station with which Calcutta is compared been situated seven or eight degrees to the north of Bombay, the rule would probably have been without exception. The influence of what he calls the "relative barometric anomalies" upon the distribution of rainfall in India has been pointed out by Mr. Blanford on more than one occasion since 1868, and the examples here given will illustrate and enforce this point.

Mr. Broun's remarks regarding the relations between the range of the monthly means of barometric pressure and that of the monthly mean temperature, are interesting as confirming the views put forward by General Strachey, as long ago as 1850, in an unpublished work on the physical geography of the Himalaya and the neighbouring countries. The range of the monthly mean pressure at Calcutta is 0·488 inch, and that of the monthly mean temperature 18°·6 F. The range for one degree is therefore ·026 inch, a figure which differs little from those for Madras, Bombay, and Trevandrum. S. A. HILL

Allahabad, December 7, 1878

Intellect in Brutes

In answer to the objections raised by W. P. Buchan and Henry Muirhead to the case of rats gnawing water-pipes for the express purpose of obtaining water, as described in my letter to NATURE, vol. xix. p. 365, I propose to give particulars of the situation of the pipes so gnawed in two instances. No. I. At Poplar. Pipe laid on second floor, between flooring-boards above and ceiling below, between joists the usual distance apart; plenty of room all round pipes to obtain access to any part of the floor, also rat-holes in woodwork to facilitate communication. As the pipe lay above the ceiling of the floor below, there was no necessity to attack the pipe in order to get through that ceiling—if that were desired. A hole could easily have been made at any point on either side of the pipe. The upper floor was a corn loft, and it is inferred from the circumstances, that the rats, feeding upon this very dry food, had tapped the water-pipe to obtain a supply of water close at hand. No. II. On Haverstock Hill. Cistern in scullery about six feet from the floor, pipe (lead), comes thence down wall, passes under floor of scullery to kitchen to supply kitchen boiler. Pipe laid on the *earth*, between joists, raised, of course, on bricks. Pipe gnawed on upper side. Plenty of room all round for rats to pass freely under all parts of the floor, as any practical builder will readily understand. They could have tunnelled *under* this $\frac{3}{4}$-inch pipe from either side through the soft earth. Of the two holes in the pipe one will admit a small pin, the other is about $\frac{1}{20}$th of an inch in greatest diameter, and about an inch from the first. These are transverse perforations, the ineffectual attempts are in a longitudinal direction. It is of course quite possible, as in Mr. Buchan's cases, that rats occasionally find gas-pipes in their way and are *compelled* to attack them, but I do not think any of your readers will imagine that his question, "Now, are they cut to get at the gas?' needs a moment's consideration. Possibly some of your correspondents may be able to corroborate the following—A ship's carpenter told me that, in the old days before the use of iron tanks on board ship became general, the rats used to attack the water casks, cutting the stave so thin that they could suck the water through the wood, without actually making a hole in it. If any one could substantiate this it would have an important bearing on the question under consideration.

ARTHUR NICOLS

I AM glad my remarks have elicited others, for I want to have my difficulty solved, which I will put thus:—Why is it that no dog ever (to my knowledge, of course) observed a person ring a bell, noticed that the bell brought the servant, and then went through the process of reasoning—"Because such was the result I will ring the bell too"? This I call abstract reasoning. On the other hand, why is it at all necessary to teach the dog to ring the bell? for it is not necessary to teach a boy. Boys do acquire sooner or later abstract reasoning, but it is with them practically a feeble power, as I have shown, and with rustics it seems, sometimes, to be totally in abeyance, as the following illustration will show. An entertainment was given to some hundred labourers and their wives, and a Mr. Cross told them to spend the afternoon in a field, but hoped none of them would be *his name*. Not one understood him, or could go through the simple process of reasoning—"We are not to be his name, his name is Cross, therefore we are not to be cross." It is this *mental reflection* which seems to me to be wanting in animals; thus, monkeys will warm themselves by a fire of burning sticks, but do not seem capable of thinking—"Because sticks burn, therefore, if I put more sticks on the fire I shall get more warmth." I should be extremely glad to hear of any cases of such purely *abstract mental reflection* in animals, for at present, there seems to me to be a hiatus here.

GEORGE HENSLOW

On the Freezing of Lakes

WE wish to draw your attention to a statement contained in an article under the above heading which appeared in NATURE last week, p. 412.

The author, Mr. J. Y. Buchanan, says:—

"Most of the observations were made with one of Negretti and Zambra's 'half turn' deep-sea thermometers, which proved a useful instrument for this species of inquiry. It was necessary, however, to fit it with a suitable inverting contrivance, as the apparatus supplied for this purpose by the makers is quite useless."

Fortunately this thermometer and apparatus has now been in use for some time, and its performance fully tested by persons whose opinion is of the highest value. We can only say that had Mr. Buchanan used the apparatus according to our printed direction, viz., lowered the instrument to the required depth, let it remain a few seconds, and then pulled it up as fast as practicable and without stopping, he would not have failed to have obtained correct results. We cannot possibly imagine how he could have failed; had we not ourselves tried the inverting apparatus in every possible way, and had we not received the highest testimony as to its efficiency, we would have remained silent, but as it is, and knowing we have invented as good an instrument as has ever been contrived for the purpose, we cannot allow the statement to pass unchallenged that we have supplied a useless apparatus. If Mr. Buchanan could not obtain satisfactory results with our apparatus it must only have been because he did not use it as we directed.

HY. NEGRETTI AND ZAMBRA

THE MIGRATION OF BIRDS

MORE than four years ago an article, headed as above, appeared in this journal (vol. x. p. 415) giving rise to some comments of more or less importance (*tom. cit.*, pp. 459, 520, and xi. p. 5). Since that time two very remarkable treatises on the subject have come forth, the one by Dr. Palmén, on the routes taken by birds in their migrations, and the other by Dr. August Weissmann, dealing generally with the whole question.[1] The first, originally published in Swedish,[2] was translated into German soon after, and in due time was reviewed in these columns (vol. xv. p. 465). An excellent English version of the second has recently appeared in the "Contemporary Review" (February, 1879, p. 531), and therefore my readers may be presumed to be acquainted with the views of both authors. It cannot be denied that each of them has to some extent enlarged the boundaries of our knowledge of the subject, and still more widely those of our speculations upon it.

As regards Dr. Palmén's work, the opinion held by his reviewer in these columns as to the assignment of routes to the migratory birds of North-Western Europe being "purely conjectural" is one that I wholly accept. I should even be inclined to go further, and say that it might be called rash, as it is evident that no such observations as would justify its adoption exist. Still I concur with the reviewer in that I would not at present term it entirely erroneous, though I venture to express my entire disbelief in the route "X." This is supposed by Dr. Palmén to start from Greenland and Iceland, and to pass by the Færoes to the Hebrides, when, after coalescing for a short distance with one or more lines from the north-east, it either loses itself on the West Coast of Ireland, or, running down St. George's Channel, skirts Scilly and crosses to the shores of the Bay of Biscay. Space forbids my entering into details which would show, I think, that this route is altogether imaginary. I will only say that what we know of the movements of two very characteristic summer visitants to Iceland, *Motacilla alba* and *Limosa ægocephala*, points to that conclusion, and I would leave it for Irish ornithological observers to prove whether Dr. Palmén is right or not.

Dr. Weissmann, happily for him, has no such compunction. He fully accepts Dr. Palmén's conjectures as absolute truths. Suppose, however, we assume them to be established—and there seems no reason why further observation should not establish most of them—they would show in Dr. Weissmann's opinion that the migrating birds of to-day in crossing the sea follow what once were "land-bridges" (*Landbrücken*), that is, isthmuses of dry land separating seas or oceans under which they are now submerged. The existence of such former terrestrial communications between continent and con-

[1] Sammlung gemeinständlicher wissenschaftlicher Vorträge. XIII. Serie Heft 291. "Ueber das Wandern der Vögel." Berlin, 1878.
[2] Om Foglarnes flyttningsvägar. Helsingfors, 1874.

tinent, at the present time revealed to us by shallow soundings and some mountain-peaks changed into islands, may be indubitable. I, at least, in regard to Europe and Africa do not question it, and it may be true all the world over. But this same hypothesis has been more or less hinted, if not absolutely promulgated, by Prof. Baird (*American Journal of Science and Arts*, May, 1866) and Capt Hutton (*Trans.* N. Zealand Inst., v. p. 235). So far, then, there is nothing novel in the Doctor's views.

In like manner Dr. Weissmann seems to me to have been anticipated by Capt. Hutton (*ut suprà*) and by Mr. Wallace (NATURE, vol. x. p. 459) in his explanation of why birds migrate at all. The only material difference between the last of these authors and the Doctor is that, while Mr. Wallace most rightly (as it seems to me) regards migration as originating with the bird at its breeding-quarters, Dr. Weissmann considers it to begin with the bird in its winter retreat. Perhaps this does not much matter, but it is as well not to put the cart before the horse if you want to prosper in your journey, and so long as lack of food be admittedly the strongest incentive to migration, it seems preferable to look on migration as beginning where that incentive is strongest. This, it scarcely needs to be said, is when, towards the close of summer, the supply of food grows scarce.

However, the most important part of the whole business is the question how the birds find their way to the places whither they repair, whether for the purpose of breeding or for that of procuring sufficient sustenance. Dr. Palmén regards it simply as a matter of "experience," and Dr. Weissmann hardly differs from him. It is "practice" (*Uebung*), says the latter—not indeed the practice acquired by the single bird, but the practice acquired by the whole species. "This faculty (*Virtuosität*) of finding the way has not arisen suddenly, but most gradually, in the course of many thousands of generations." Now with all my faith in the marvellous results which are doubtless produced by the hereditary transmission of certain qualities, I think some caution is needed before we accept "practice" as the true explanation of the puzzle. Dr. Weissmann says that he does not see what more is needed than a fine power of observation and a keen eye to take in every thing of importance for a knowledge of the way, and then a very remarkable memory for places by means of which all details of the long route shall be retained. The knowledge of direction (*Orientirung*) will then follow of course. Subsequently he takes the instance of a woodpecker being able to find the tree containing its nest, though surrounded by hundreds of similar trees, and declares that this knowledge or sense of direction must, in the case of birds when migrating, be wholly analogous. He suggests also that the height at which birds sometimes fly, referring apparently to a remark by Mr. Tennant (NATURE, xiii. p. 447), would enable them to cross the Mediterranean, and seldom or never lose sight of land.

This may be; but migration goes on in other parts of the world, and a good explanation ought to apply elsewhere. Will Dr. Weissmann's hold good for our Antipodes? In regard to New Zealand Capt. Hutton has remarked (*Trans.* N.Z. Inst., v. p. 235):—"That we should have two cuckoos which migrate regularly to other countries, each more than a thousand miles distant, is a fact that deserves special attention, for I know of no parallel case in any other part of the world, the distance across the Mediterranean being less than half that travelled over by our summer visitors." These two cuckoos are *Chrysococcyx lucidus* and *Eudynamis taitensis*, the former, it is supposed, making its annual journeys to and from Australia,[1] and the latter to and from the Friendly Islands or the Fijis, it being found in both groups, to say nothing of other places further off. Let us consider the case of the *Eudynamis*. Due north of New Zealand there appears to be no land until Fiji is reached, but a little to the westward of the direct line lies Norfolk Island and its companions, and about as far to the eastward are the Kermadecs. Of these, the most southerly is 450 miles from New Zealand, and the most northerly about the same distance from Pylstaart, an outlier of the Friendly Islands. The *Eudynamis* starting from New Zealand for the northward would have nothing to supplement its inherited "sense of direction" save the landmarks offered to the right and left by the Kermadecs and Norfolk Island respectively. To see the former it would have to mount to the height of some twenty miles,[1] and to again mount about as high on leaving the Kermadecs on its way to Pylstaart. It might be urged that the bird having by "practice" a sense of the direction in which it ought to go, might fly half the distance, keeping the land of departure in sight—though, considering the position of birds' eyes, this would not be easy—and then, without exceeding the level of six or seven miles, it might behold the Kermadecs, but even this is an elevation far beyond Dr. Weissman's 20,000 feet. The route by Norfolk Island being longer, need not here be discussed.

[1] I should rather suspect to and from New Caledonia.

It is much to be desired that something positive were known as to the height at which it may be possible for birds to perform their passages, but on this point we have (so far as I am aware) little information. The experiments made by Mr. Glaisher on the six pigeons taken up in his celebrated balloon ascent, September 5, 1862 ("Rep. Brit. Ass.," 1862, p. 385), unfortunately admit of no definite deductions. One pigeon thrown out at the height of three miles "extended its wings and dropped as a piece of paper." A second at four miles "flew vigorously round and round, apparently taking a dip each time." A third between four and five miles "fell downwards as a stone." A fourth at four miles, in the descent, "flew in a circle," and then alighted on the balloon. The two remaining pigeons were brought down, and one was found to be dead! Perhaps a little more "practice" or "experience" was wanted, but at any rate the results do not seem to favour the notion that birds can fly comfortably at those heights. Nor is this surprising, considering the well-known effects of the rarification of the air at great heights. I of course pretend to no special knowledge of this subject, but Mr. J. W. L. Glaisher, F.R.S., kindly informs me that at an elevation of five miles the density of the air is about $\frac{1}{2{\cdot}7}$ of what it is on the earth's surface, at an elevation of seven miles about $\frac{1}{4{\cdot}1}$, and of ten miles about $\frac{1}{7{\cdot}5}$. I know not whether experiments have been made to test the endurance of a bird's life under such a condition as the last, but it could of course be easily produced under an air-pump. It would not be so easy to test the power of flight under the same condition. It is only obvious that the power would be very greatly diminished, and I should be glad to learn the results of any investigation of this kind. Physicists and physiologists might here give ornithologists great help.

But to return to the question of distance and sight. How comes it that the American Golden Plover (*Charadrius virginicus*) passes regularly every year in large flocks over the Bermudas, 600 miles from the nearest point of land, and that a point whence these flocks certainly do not take their departure. If the islands are "still vext" by stormy weather, the flocks alight and afford the inhabitants a good deal of sport. If the weather be fine, the flocks seem to continue their southward course. Nor is this plover the only *regular* visitant. The American Night-Hawk (*Chordiles popetue*) is as constant in its appearance at spring and fall, and so are

[1] Of course the exact height would depend on the elevation of the land, concerning which I have no information.

more species of *Limicolæ*, and perhaps of other groups, than I can here name. Is it to be supposed that all these birds, some of them flying by night, make Bermuda by the means which Dr. Weissmann considers sufficient? If his explanation is good it must be good for New Zealand and Bermuda, as well as for the Mediterranean. But there is yet a stronger case to be cited. The Sandwich Islands, as I have learned on authority I cannot doubt (though I know not any mention of the fact in print), are yearly visited like Bermuda, but with even greater punctuality, by large flocks of Golden Plovers—whether *C. virginicus* or *C. fulvus*, is undetermined, but that does not much matter. If the birds belong to the first of these forms they must come from the west coast of America, if to the second from the east coast of Asia. Now there is no land between the Sandwich Islands and the Californian or the British-Columbian coast, but between them and the Aleutians, as I learn from Mr. Rye, there is one islet, Roca de Plata or Crespo. This, however, does not lie in a straight line, and is some 720 miles north-west of the Sandwich Islands, and 1,200 south-west of the Aleutians. Running generally westward of the Sandwich Islands is a series of islets, at distances, perhaps, not exceeding 150 miles, which no doubt might serve as guide-posts for the plovers did they but make for them, but the series comes to an end in about long. 178° W., and though by turning suddenly to the north-east from Morell Island towards Mellish Bank (300 miles), the Aleutians again appear as the nearest land in a northerly direction, the distance of 1,020 miles has to be covered! On the supposition that the birds are of Asiatic birth, and therefore come by another course, we find that due west of Morell Island is Ganges Island, but that is 930 miles off, and thence to reach the easternmost of the Japanese group is 690 miles further! Thus, whichever form of golden plover it be that visits the Sandwich Islands, its regular advent there needs, I think, some fuller explanation than that afforded by Dr. Weissmann's theory.

Then again, there is another set of facts which seem to me irreconcilable with the theory of mere "practice" or "experience." It must be remembered that though Dr. Weissmann relies most on the inherited practice of the *species*, still he does not neglect the *individual*, and both he and Dr. Palmén make considerable use of the observation that adults, and male adults in particular, lead the migratory flocks. This fact, so far as I am aware, has only been noticed in the northward movement in spring, and elsewhere I have endeavoured to account for it ("Encycl. Brit.," ed. 9, iii. p. 767). In autumn it may be doubted whether there is anything of the kind, and we have in many species, the young of the year—birds that are but three months old, or even less, migrating southward with the greatest regularity unaccompanied by adults. This seems to happen with nearly all the *Accipitres*, nearly all the *Limicolæ*, and perhaps, some others, that are bred in arctic or subarctic districts. It happens also with our own Cuckoo (*Cuculus canorus*), and this case is still more wonderful, for the young Cuckoo has had no communication whatever with its progenitors (who have already taken their departure from our shores some weeks earlier), and its foster-parents with us are generally species which do not migrate to any great extent—the Hedge-Sparrow (*Accentor modularis*), Titlark (*Anthus pratensis*), and Pied Wagtail (*Motacilla lugubris*). Yet our young Cuckoos, starting alone and travelling over utterly unknown country, must, on the whole, successfully reach their destination, or the breed would become extinct here.[1] Dr. Weissmann may indeed well say of migrating birds, that the young, when it cracks the shell, possesses "great geographical talent"!

I might easily prolong this article, for there is much more to be said on the subject, and in some details, by no means unimportant, Dr. Weissmann seems to have fallen into errors that I have not here noticed, but my chief object in making these remarks has been to hinder persons who have not previously thought on the matter from taking his easy explanation of the mystery of ornithological mysteries to be sufficient. Believing, as I once before said, that its solution is probably simple in the extreme, and having a strong faith in the hereditary transmission and accumulation of faculties so as to become a wonder-working power, I yet cannot think that he has succeeded in making known the secret and in satisfactorily explaining how birds cross "the sacred spaces of the sea."

ALFRED NEWTON

[1] Since I wrote this I have heard from Mr. Gätke, so well known for his observations on migratory birds, that young Starlings pass over Heligoland during July by hundreds of thousands, "without a single old bird accompanying them," while the old birds begin to migrate at the end of September and continue for the next two months.

THE DIMENSIONAL PROPERTIES OF MATTER IN THE GASEOUS STATE

BY assuming a sufficient number of sufficiently insignificant individuals to constitute a group, it is possible to imagine a state of things in which as far as it can be observed from a certain distance, all evidence of individual action is entirely lost. In this way has been framed the molecular hypothesis or kinetic theory of gas. But it must be obvious to every one who has considered this molecular hypothesis, that the apparent uniformity in the actions we perceive must be the result of the distance (so to speak) from which these actions are observed, and that could we sufficiently localise (as regards time and space) our observation, we must perceive in all their varieties the individual actions of the molecules. And even failing this, between the actions of the individuals and the absolute mean action there must be local or parochial actions which would be distinguishable at greater distances than the purely individual actions.

In order that the properties of a gas may appear perfectly uniform in all directions and quite independent of the shape and volume of the space which the gas is constrained to occupy, the number of molecules must be countless, and the temporary action of each individual must be confined to an imperceptibly small portion of the space observed. If these conditions are not fulfilled then the properties of the gas will not be uniform, and we must have dimensional properties depending on the dimensions of the constraining surfaces.

The idea of our being able actually to perceive such properties does not appear to have been entertained hitherto. Until fifty years ago, all the mechanical properties of gases were regarded as quite uniform, the only mechanical distinction between one kind of gas and another being that of weight. Since that time in the phenomena of diffusion, and the phenomena attending the passage of gases through minute channels, properties of gases have been recognised which readily distinguish between one kind of gas and another, and even more than this, for Graham found that there was a difference in the relative behaviour of different gases in differing through porous plates of different coarseness. Still, neither Graham nor any one else appears to have recognised evidence of dimensional properties.

Neither did the development of the mathematical theory lead to the revelation of dimensional properties. Since 1864 it has been known that this theory included the explanation of all the uniform properties of gas. But in developing this theory attention appears to have been paid exclusively to the mean of the motions. And although Prof. Maxwell points out that there must ultimately be dimensional properties, he has not pursued the investigation, so as to reveal their character.

In 1874 a very remarkable phenomenon was brought to light by the experiments of Mr. Crookes—that in ex-

tremely rare media light bodies are apparently repelled by hot and attracted by cold bodies. At first this was not recognised as a gaseous phenomena—in fact the non-presence of gas was supposed to be essential to the occurrence of the highest form of the action.

That such motions might result from the inequalities in the pressure of the residual gas caused by the communication of heat between the objects and the gas, was first shown by the author in May, 1874 (*Proc.* Roy. Soc. 1874, p. 402).

It was shown that when heat is passing from a surface to a gas whether by direct communication or by evaporation the reaction from the receding molecules causes an excess of pressure proportional to the heat communicated.

The reasoning was definite so far as it went and, although manifestly incomplete, the conclusion arrived at, viz., that the phenomena resulted from the heat communicated to the residual gas appears very soon to have been generally accepted as it was found to be verified in various ways. Several papers appeared in which attempts were made to render the explanation more complete, but these attempts were for the most part based on a misconception of the phenomena to be explained and were altogether wide of the mark.

In November of 1878 the clue to the step that was wanting to complete the explanation occurred to the author. It was then seen that although the surfaces with which the phenomena occurred were of limited extent, no account had been taken of this fact in the attempts to explain the actions. Having once hit on this point the deduction of a complete theory of the phenomena was only a matter of labour. It was found that although the excess of pressure is proportional to the quantity of heat communicated, it also contains a factor which is proportional to the divergence of the lines of heat flow; and hence the reciprocal of the density of the gas at which the phenomenon would occur should vary inversely as the size of the vanes. So that by using vanes of comparatively small size the phenomena should be obtained at proportionally greater densities of the gas.

On considering how this conclusion might be experimentally tested it appeared that in order to obtain any results at measurable pressures the vanes would have to be very small indeed, too small almost to admit of experiment. It was while searching for some means to overcome this difficulty that it became apparent that if the vanes were fixed, then, instead of the movement of the vanes, we should have the gas moving past the vanes—a sort of inverse phenomenon—and then instead of small vanes small spaces might be allowed for the gas to pass. Thus the probable existence of phenomena of *Thermal Transpiration* was suggested, and it was obvious that the porous plug would furnish the means of verifying the conclusions. This probable connection between the phenomena of the radiometer, which may be called *Impulsion*, and the phenomena of transpiration through porous plugs raised the question whether the same extension of the dynamical theory of gas which explained the radiometer would not include the results obtained by Graham not then explained. This idea was followed up, and a method was devised of extending the dynamical theory of gases so as to take into account the forces tangential, and normal, [arising from] a varying condition of molecular gas.

This theory appeared to explain fully all the results established by Graham as well as the then known phenomena of impulsion (the radiometer), besides definitely indicating the phenomena of thermal transpiration to be expected, as well as the effect of employing small vanes in the radiometer. That this step had been accomplished was intimated by the author in the following passage in a letter published in NATURE, vol. xix. p. 220.

"Now, however, I have arrived at a result, which, although somewhat unexpected and striking, will, I hope, be found to reconcile what has hitherto appeared to be anomalous in the phenomena already known, and to have suggested certain hitherto unexpected phenomena which now only await experimental verification."

This experimental investigation which was at once commenced, proved to be a much more serious undertaking than had been anticipated, and was not completed until the end of August, this was not so much on account of difficulties, although these were considerable, but because it was found possible to do so much more than had been expected.

One of the results of the investigation was to show that a difference of pressure is maintained whenever two chambers of the same gas are separated by a porous plate, one face of which is hotter than the other.

With a plate of meerschaum ·44 inch thick, one side of which was something less than 212°, while the other side was about 50°, the difference of pressure was ·25 inch of mercury with air at the atmospheric pressure, and ·88 of an inch with hydrogen at the same pressure.

The existence of this thermal transpiration, although a new phenomenon, is not considered to be the most important result of this part of the investigation, for it appeared on comparing the results obtained with different plates, and different densities of gas, that there was a constant relation between the pressures for different plates at which proportional results were obtained. Thus comparing a plate of stucco with a plate of meerschaum, it was found that the ratios of the difference of pressure to the mean pressure, was the same for both plates so long as the mean pressure with the meerschaum was six times greater than with the stucco, and that this law held although the mean pressures with the meerschaum ranged from 30 to 1·25 inches of mercury. This ratio of the pressures at which corresponding results were obtained, was the same whether the gas used were hydrogen or air; and for plates of different thickness, and hence it was clearly shown to depend only on the coarseness of the plates.

Thus in thermal transpiration we have a phenomenon of gaseous motion depending on a relation between the density of the gas and the dimensions of the space which it is constrained to occupy. The discovery of this relation between the density of the gases and the coarseness of the plates at which corresponding results of thermal transpiration were obtained, suggested the possibility of obtaining a like relation for corresponding results when the gases were forced through the plates by a difference of pressure. Graham had found that the relative rates at which different gases transpired through plates differed very considerably with the coarseness of the plates and no explanation had been given of the phenomena. On trying the experiments not only was it found that with plates of different coarseness corresponding results were obtained whenever the pressures of the gas have a constant ratio but it was also found that with the same plates the ratio was the same as in the case of thermal transpiration.

A successful attempt was then made to verify the conclusion that the phenomena of the radiometer might be obtained at higher densities by using smaller vanes. By suspending fibres of silk and spider lines the repulsive action of heat was rendered apparent at pressures ranging up to the pressure of the atmosphere.

These results, as well as the theory from which they were deduced, have been fully described in a paper, an abstract of which was read before the Royal Society on the 6th inst.

As regards transpiration and impulsion, the investigation appears to be complete; most, if not all, of the phenomena previously known have been shown to be such as must result from the tangential and normal stresses consequent on a varying condition of a molecularly constituted gas; while the previously unsuspected

phenomena to which it was found that a variation in the condition of gas must give rise, have been found to exist.

The results of the investigation lead to certain general conclusions which lie outside the immediate object for which it was undertaken; the most important of these is that gas is not a continuous plenum.

The experimental results considered by themselves bring to light the dependence of a class of phenomena on the relations between the density of the gas and the dimensions of the objects, owing to the presence of which the phenomena occur. As long as the density of the gas is inversely proportional to the coarseness of the plates, the transpiration results correspond; and in the same way, although not so fully investigated, corresponding phenomena of impulsion are obtained as long as the density of the gas is inversely proportional to the linear size of the objects exposed to its action; in fact, the same correspondence is found with all the phenomena investigated.

We may examine this result in various ways, but in whichever way we look at it, it can have but one meaning. If in a gas we had to do with a continuous plenum, such that any portion must possess the same properties as the whole, we should only find the same properties, however small might be the quantity of gas operated upon. Hence, in the fact that we find properties of a gas depending on the size of the space in which it is inclosed, and on the quantity of gas inclosed in this space, we have proof that gas is not continuous, or, in other words, that gas possesses a dimensional structure.

In virtue of their depending on this dimensional structure, and having afforded a proof thereof, it is proposed to call the general properties of a gas on which the phenomena of transpiration and impulsion depend, the *Dimensional Properties of Gas*.

Although the results of the dimensional properties of gas are so minute that it has required our utmost powers to detect them, it does not follow that the actions which they reveal are of philosophical importance only; the actions only become considerable within extremely small spaces, but then the work of construction in the animal and vegetable worlds, and the work of destruction in the mineral world, are carried on within such spaces. The varying action of the sun must be to cause alternate inspiration and expiration, promoting continual change of air within the interstices of the soil as well as within the tissue of plants. What may be the effect of such changes we do not know, but the changes go on; and we may fairly assume that, in the processes of nature, the dimensional properties of gases play no unimportant part.

OSBORNE REYNOLDS

OUR ASTRONOMICAL COLUMN

THE BINARY STAR *a* CENTAURI.—Dr. Doberck, with the aid of measures made during the last few years has calculated elements of *a* Centauri, which, though given as only provisional, will doubtless approach nearer to the true ones than any previously published. They are as follows:—

Passage of the peri-astre	1875·12
Node	25° 32′
Angle between node and peri-astre	45° 58′
Inclination	79° 24′
Excentricity	0·5332
Semi-axis major	18″·45
Period of revolution	88·536 years.

Comparing this orbit with weighted means derived from Mr. Gill's measures at Ascension in 1877, the following differences are shown:—

1877·614	...	Position	+ 2°·32	... Distance	− 0″·23
1877·858	...	,,	− 0·39	... ,,	+ 0·05

For 1879·5 the elements give position, 173°·4; distance, 3″·47; and for 1880·5, position, 185°·2; distance, 5″·30; the smaller star will be due south of the larger one at the beginning of 1880, distant 4″·37. The above value for the semi-axis major, taking the annual parallax of *a* Centauri, a mean between the values of Maclear and Moesta, indicates that the mean distance between the component stars is rather greater that the mean distance of Uranus from the sun. Frequent measures of *a* Centauri during the next few years are much to be desired.

A NEW VARIABLE STAR IN SAGITTARIUS.—The following case appears a singular one, if the star is not variable to a considerable extent:—On April 28, 1783, D'Agelet observed a star which he estimated of 4·5m., and which is No. 4,627 in Gould's Catalogue. It does not occur in Piazzi or Lalande, nor in Bode, but it is found on Harding's Atlas as 6m. It is wanting in the Uranometries of Argelander and Heis, but the former observed it three times in his Zones. In Z. 218, July 2, 1849, it is rated 5m.; in Z. 225, on July 13, only 7m.; and in Z. 391, June 30, 1851, it is 5·6m. The mean position for 1850 from Argelander's observations is in R.A. 17h. 59m. 6·57s., N.P.D. 107° 10′ 9″·9, or reducing to 1880 in R.A. 18h. 0m. 51·1s., N.P.D. 107° 10′ 10″. It is difficult to account for such an object having escaped the notice of other observers, except upon the supposition of variability; perhaps, like some other variables, it is only conspicuous for a short time. The star follows 6 Sagittarii 6m. 26s., in 1′·4 greater N.P.D. It is proper to state here that Mr. J. E. Gore, in his "Southern Stellar Objects," p. 104, has a reference to this star amongst stars possibly variable, but the observations of D'Agelet and Argelander do not appear to have been known to him.

NEW MINOR PLANET.—No. 193 was discovered by M. Coggia at Marseilles on March 1, not far from the place of No. 192, detected at Pola by Herr Palisa, in the previous month.

INTRA-MERCURIAL BODIES.—In a letter addressed to M. Mouchez, communicated to the Academy of Sciences at Paris on March 3, Padre Ferrari, Director of the observatory of the Collegio Romano, mentions that, having had occasion to institute researches respecting the observation of a rapidly-moving spot upon the sun's disk by De Cuppis on October 2, 1839, at the instance of Prof. Oppölzer, he had met with particulars of a similar observation by De Vico in 1837. Reference is made to this observation in "Memoria intorno ad alcune osservazioni fatte alla Specola del Collegio Romano, 1838," p. 15, but the year only is there mentioned. De Cuppis, a friend and frequently co-operator of De Vico's has, however, preserved the date in the journal *L'Album* for 1838, July 7, where the observation is thus described: "In una osservazione del 12 luglio, 1837 parve al sullodato astronomo (De Vico) del Collegio romano veder rinnovato il fenomeno, in una piccolissima macchia perfettamenta rotonda e senza traccia della cosi detta penombra, la quale nel breve spazio di 6 ore trascorse buona parte del disco solare."

This observation does not occur in Haase's Collection, nor is there here more than a reference to the observation of Decuppis, which is thus given in a note by Arago at the sitting of the French Academy on December 16, 1839:—"M. Decuppis annonce que le 2 Octobre, en continuant des observations qu'il faisait sur les taches du soleil, il a vu une tache noire, parfaitement ronde et à contours nettement terminés, qui s'avançait sur le disque de l'astre d'un mouvement propre rapide, de manière à ce qu'elle a dû en traverser le diamètre dans environ six heures. M. Decuppis pense que les apparences qu'il a observées ne peuvent s'expliquer qu'en admettant l'existence d'une nouvelle planète."

There are other observations upon record in January

and July which might apply to the object seen by De Vico, assuming it to have been an intra-Mercurial planet. Leverrier did not attempt to discuss these observations, confining his attention to those made about the equinoxes, clearly belonging to a different body.

GEOGRAPHICAL NOTES

SOME of our contemporaries have been a little premature in appointing the Earl of Northbrook to the presidency of the Royal Geographical Society, for at the time when the announcement was first made his lordship was not even a fellow of the Society. The fact, we believe, is that Lord Northbrook has expressed his willingness to accept his nomination by the Council, but there is no likelihood of any election taking place till the anniversary meeting on May 26th.

AT the meeting of the Geographical Society on Monday evening Dr. James Stewart, of the Livingstonia Mission, East Africa, read a paper on the "Second Circumnavigation of Lake Nyassa." The voyage was undertaken in the little steamer *Ilala* in the latter part of 1877. It was found that Lake Nyassa has hitherto been laid down on our maps too far to the east, and that its position ought to be shifted at the north end as much as thirty miles to the westward. Dr. James Stewart was also fortunate in discovering two harbours such as were needed for the safe navigation of the lake; the one Rombashi inlet or river on the northern coast, and the other the Kambwe lagoon a little to the south of it on the west coast. Mr. James Stevenson afterwards gave a few particulars respecting the explorations now being carried on by Dr. Laws and Mr. James Stewart, of the Bengal Civil Service, in the country on the western side of Lake Nyassa.

THE Abbé Debaize, the leader of the French expedition to Central Africa, sends to M. Richard Cortambert a letter, rejoicing at the success of his expedition so far. He writes from Taboro, in Unyamwezi, and states that hitherto he has been completely successful; there have been no desertions, little expenditure, and no misfortunes of any kind. This good fortune he ascribes to his own excellent health, to his firm discipline, and his personal superintendence of all arrangements. He has a very poor opinion of Miramboa, and thinks the English are striving hard to become masters in Central Africa; indeed he hints that "annexation" is not far off. At Mpwapwa, where the sole white population are an English "reverend, a mason, and a carpenter," there are already four stone houses, while there are English stations in Ukerewe, Uganda, and at Ujiji.

THE *Daily News* Lisbon correspondent states that the Portuguese Minister of Marine has informed the Cortes that he has received a telegram stating that the Portuguese African explorer Pinto, who was separated from his companions at Bihe, has succeeded in traversing Africa from west to east, having reached the Transvaal.

FRANCE and the United States will soon establish a comparison of the longitude of Paris and Washington by cable. As is known, these operations lead to a determination of the velocity of propagation of electric waves. Commander Perrier and M. Lœwy have recently published a volume giving the details of the comparison between Paris, Marseilles, and Algiers.

MR. STANFORD has just published a very fine stereographical map of Zululand, with portions of the adjoining territories. On the bases of what observations there are as to the physical conformation of the country, together with the pretty fair notions we have of the courses of the rivers, a good general notion is conveyed of the character of the surface and its various levels. The map conveys, moreover, a great amount of information in a clear and striking manner, that will be extremely useful to those who wish to understand the history and bearings of the Zulu difficulty.

UNDER the title of "Le Maroc" the current number of the *Tour du Monde* contains the commencement of a translation of M. Edmondo de Amicis' account of his experiences in Morocco in 1875. The present instalment deals with Tangier, and is accompanied by several illustrations.

WE understand that Prof. Geikie, of Edinburgh, will probably deliver a lecture on Geographical Evolution before the Royal Geographical Society on Monday, March 24.

THE Emperor of Austria has presented Captain von Oestreicher with the medal for letters and arts (*literis et artibus*) in recognition of his recent highly interesting geographical work, "Aus fernem Osten und Westen."

DURING last year the following journeys were made by Russian explorers in Central Asia:—Generals Stolyetoff and Razgonoff were accompanied during their mission to Kaboul by several topographers and explorers; M. Oshanin has made explorations in Karategin and Hissar; M. Matséeff in Badakshan and Eastern Afghanistan; M. Grodékoff in Western Afghanistan and Herat; M. Bykoff has explored the Amu darya River from Kobadian to Khiva; M. Yavarsky has traversed for the fourth time the region between Tashkend and Kaboul; M. Mayeff has visited for the second time the hilly track between Karshi, Keliff (on Amu darya), Kobadian, and Hissar; and, finally, the steamer *Samarkand* has navigated the Amu, from Petro-Alexandrovsk to Khodja-Sale.

UNDER the title of Société de Géographie de l'Est, there has been founded at Nancy a new geographical society.

A STUDY IN LOCOMOTION[1]

IF the interest of a scientific expositor ought to be measured by the importance of the subject, I shall be applauded for my choice. In fact, there are few questions which touch more closely the very existence of man than that of animated motors—those docile helps whose power or speed he uses at his pleasure, which enjoy to some extent his intimacy, and accompany him in his labours and his pleasures. The species of animal whose co-operation we borrow are numerous, and vary according to latitude and climate. But whether we employ the horse, the ass, the camel, or the reindeer, the same problem is always presented: to get from the animal as much work as possible, sparing him, as far as we can, fatigue and suffering. This identity of standpoint will much simplify my task, as it will enable me to confine the study of animated motors to a single species; I have chosen the horse as the most interesting type. Even with this restriction the subject is still very vast, as all know who are occupied with the different questions connected therewith. In studying the *force of traction* of the horse, and the best methods of utilising it, we encounter all the problems connected with teams and the construction of vehicles. But on a subject which has engaged the attention of humanity for thousands of years, it seems difficult to find anything new to say.

If in the employment of the horse we consider *its speed* and the means of increasing it, the subject does not appear less exhausted. Since the chariot races, of which Greek and Roman antiquity were passionately fond, to our modern horse-races, men have never ceased to pursue with a lively interest the problem of rapid locomotion. What tests and comparisons have not been made to discover what race has most speed, what other most bottom,

[1] "Moteurs animés; Expériences de Physiologie graphique." [Lecture by Prof. Marey at the Paris meeting of the French Association, August 29 1878.

what crossings, what training give reason to expect still more speed?

Lastly, as to what is called the exterior of the horse, and his varied paces, specialists have for long devoted themselves to this department. The horseman is trained to distinguish between these different paces, to correct by the education of the horse those which seem to him defective, to fix by habit those which give to his mount more pleasant reactions or a much greater stability. The artist, in attempting to represent the horse, seeks to transfer his attitudes more and more faithfully, to express better and better the force, the suppleness, and the grace of his motions.

These questions, so complicated, I wish to bring before you by a new method, and I hope to show you that the *graphic method* makes light of difficulties which seem insurmountable, discerns what escapes the most attentive observation; finally, it expresses clearly to the eyes, and engraves upon the memory the most complicated notions. The graphic method was almost unknown twenty-five years ago; to-day it is wide-spread. Thus, in almost all countries, recourse is had to the employment of graphic curves as the best mode of expression to represent clearly the movement of administrative, industrial and commercial statistics. In all observatories apparatus known as *registering* or *recording*, trace on paper the curves of variation of the thermometer, the barometer, rain, wind, and even atmospheric electricity. Physiology utilises still more largely recording apparatus; but I shall only require to show you a very small number of these instruments, those which serve to record forces, rates of speed, or to note the rhythms and the relations of succession of very complicated movements.

1. *Of the Force of Traction of the Horse, and the best Means of Utilising it.*—When a carriage is badly constructed and badly yoked the traveller is jolted, the road is injured, the horse is fatigued more than is necessary, and is often wounded by parts of the harness. Science and industry have long sought to discover these inconveniences, to find out their causes in order to get rid of them. But it is only in our own time that great progress has been made in this respect. When we complain of being jolted in a humble cab, we ought to go back in thought to the time when people knew nothing of the hanging of carriages. No roughness of the road then escaped the traveller. A Roman emperor mounted on his triumphant chariot was, in the midst of his glory, as ill at ease as the peasant in his cart. Except some improvements, such as the use of softer cushions, things went on thus till the invention of steel springs such as are now employed, for the leather braces of old-fashioned carriages still left much to desire.

Does this mean that the present mode of suspending carriages by four and even eight springs is the final step of progress? Certainly not. Our present springs diminish the force of jolts, transform a sudden shock into a long vibration; but the perfect spring ought always to maintain a constant elastic force, to allow wheels and axles all the vibrations which the ground demands of them, without allowing any of these shocks to reach the carriage itself. The search for this ideal spring has engaged the attention of one of our most eminent engineers. M. Marcel Deprez has found happy solutions to the problem of perfect suspension; he will, doubtless soon apply these in practice.

A good suspension also saves the carriage by suppressing the shocks which put it out of order and destroy it in a short time. Finally, suspension saves the wheel itself. On this subject let me recall a remarkable experiment of General Morin. On a high road, in good condition, he drove a diligence with four horses at the trot, and laden with ballast instead of passengers. The springs of the vehicle were raised so that the body rested on the axles. After the diligence had passed and repassed a certain number of times, it was found that the road on which it was running was notably deteriorated. The springs of the carriage were replaced and the same movements were repeated on another part of the road; the marked deterioration was no longer produced. It is thus clearly proved that a good suspension is favourable to a good condition of the roads.

But with non-suspended vehicles, in order thus to shock the passengers, disjoint the carriage, and abuse the road, force is necessary. It is the horse which must supply this; so that, independently of the useful work which we demand of them, the animal supplies still other work which gives rise to a multitude of shocks, and has only injurious effects. The employment of suspending springs has rendered the double service of suppressing injurious vibrations and of collecting into a useful form all the work which they represent.

Is this all? Do there not remain, even with the best carriages, other vibrations and other shocks which must be pursued and destroyed in order to render more perfect the conditions of traction? You have all experienced, at the moment of the sudden start of a carriage, and even at each stroke of the whip on a living horse, horizontal shocks which sometimes throw you to the bottom of the carriage. In a less degree, shocks of the same kind are produced at each instant of traction, for the speed of the horse is far from being uniform, and the traces are subjected to alternate tension and slackness. Here are veritable shocks which use up part of the work of the horse in giving only hurtful effects which bruise and contuse the breast of the animal, injuring his muscles, and, in spite of the padding of the collar, sometimes wounding him. To prove the disadvantages of this kind of shocks, some experiments are necessary. I have borrowed one from Poncelet; it is easily made, and any one may repeat it. I attach a weight of 5 kilos to the extremity of a small string; taking hold of the free extremity of this, if I gently raise the weight, you see that the cord resists the weight of 5 kilos and holds it suspended. But if I attempt to raise the same weight more rapidly, I bruise my fingers, the cord breaks, and the weight has not budged. The effort which I have made has been greater than the preceding, since it has exceeded the resistance of the cord; but the duration of this effort has been too short, and the inertia of the weight not being overcome, all my exertion has been expended in injurious work. If, instead of an inextensible cord, I had attached to the weight a cord a little extensible, the sudden effort of elevation which I made would have been transformed into an action more prolonged, and the weight would have been raised without breaking the cord and bruising my fingers. To render the phenomenon more easy of comprehension, I shall make a new experiment under conditions a little different.

You see on a vertical support (Fig. 1) a sort of balance-beam, which bears on one of its arms a weight of 100 grammes, on the other a weight of 10 grammes suspended at the end of a cord one metre long. Between these two unequal weights the beam is maintained by a spring-catch, which prevents it from falling to the side of the heavier weight, but which, on the other hand, permits the beam to incline in the opposite direction, if we bring to bear on the end of the cord an effort greater than the weight of 100 grammes. But, by letting the smaller weight fall from a sufficient height, at the moment when this reaches the end of its course, it will stretch the cord which holds it, and will develop what is called a *vis viva*, capable of raising the weight of 100 grammes to a certain height; but this elevation will only take place on condition that the application of this force does not give rise to a shock. If the cord which sustains the weight of 100 grammes is inextensible, and if that which bears the weight of 10 grammes is the same, at the moment of the fall of the latter, you will hear a snap; a shock agitates

the whole apparatus, but the weight of 100 grammes is not raised.

Now suspend this weight of 100 grammes to an india-rubber cord or an elastic spring, and repeat the experiment. You see each time that the weight falls that the 100-gramme weight is raised to a certain extent. But this elevation is effected under peculiar conditions. At the moment when the weight falls and the cord is stretched, the balance inclines, stretching the elastic spring, but the mass of 100 grammes does not yet move; it is only when this spring is stretched that the mass, obedient to the prolonged action of this elastic spring,

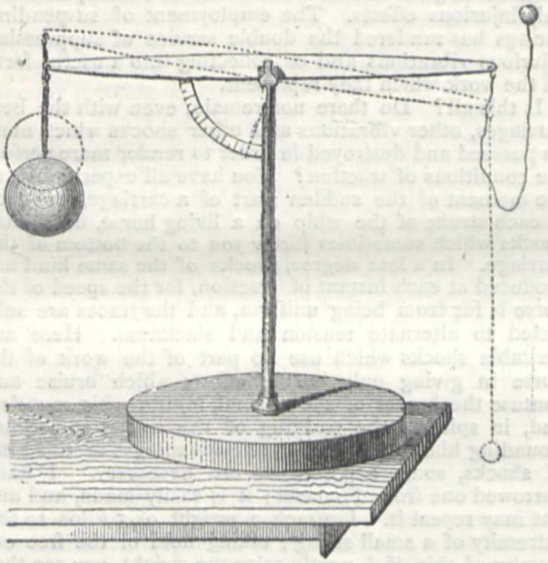

FIG. 1.—Apparatus to show that a *vis viva* directly applied to the displacement of a mass is lost in a shock, while the same force transmitted by an elastic medium may perform work.

begins to move and rises, representing a certain amount of work accomplished.

Thus, the suppression of shock in traction, economises a certain part of the moving labour; it is *then* advantageous to give to the traces of a carriage a certain elasticity. One of the most simple methods consists in interposing between the trace and the carriage an elastic medium. Here are some of these elastic pieces, which I call *tractors*. One of the patterns has been made by M. Tatin; it is composed of a spring which is compressed by traction and deadens the shock. The other is formed of a similar spring placed in the very inside of the carriage-trace.

If you wish to be convinced of the advantage of this mode of traction, yoke yourself to a hand-barrow by

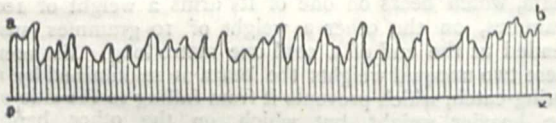

FIG. 2.—Tracing of the dynamograph for a vehicle drawn by a horse.

means of a rigid leather strap, such as you see used in the streets of Paris or London, where too often man is employed to drag burdens. When you have well noted the painful shocks which this mode of traction transmits to the shoulders, place between the strap and the barrow the elastic tractor and repeat the experiment. After that no doubt is possible; the shoulders are no longer bruised by the shaking of the pavement, and a comfort is experienced which will evidently be experienced in the same degree by a horse placed in conditions of elastic traction.

To obviate suffering to men and animals is unfortunately not a motive sufficient to induce everybody to modify the old system of harnessing. To certain minds known as *positive*, it is necessary to prove that elastic traction has economical advantages, and that a horse thus harnessed is able to draw heavier loads. This fact, which results from the experiments which you have seen, requires, to be rigorously proved, the aid of the graphic method. It is to the genius of Poncelet that we owe the record of work expended by different motors.

Everybody knows what a dynamometer is, viz., a spring which, yielding to tractions exerted upon it, is deformed in proportion to the efforts developed. Let us adapt to a spring of this kind a pencil which touches a strip of paper, and let us so arrange things that the movements of the wheel of a carriage shall impress upon the paper a motion of translation. While the effort of traction of the horse will communicate to the spring movements more or less extended, the progress of the carriage will

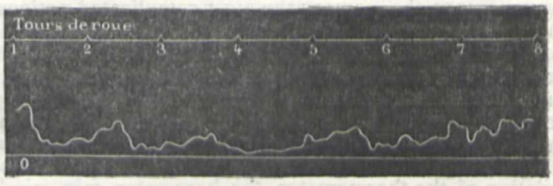

FIG. 3.—Tracing of the dynamograph for a vehicle drawn with an elastic intermediary.

draw out the paper, and from these combined movements will result a curve (Fig. 2), which can be resolved into a series of ordinates or vertical lines in juxtaposition, expressing by their unequal heights the series of efforts resulting from each element of the road traversed. The sum of these elementary efforts, otherwise the surface of paper limited in height by the flexures of the curve, will be the measure of the work expended. If we record in a comparative manner the work done by the same vehicle harnessed with rigid traces or supplied with elastic tractors, we see (Figs. 3 and 4) that the *area* of the curve is greater, that is, that there has been more work expended, while rigid traces have been used. In the most favourable cases that I have met with, the economy of work by elastic traction has been 26 per cent.

But, it may be objected, the recording dynamometer itself constitutes an elastic intermediary which suppresses

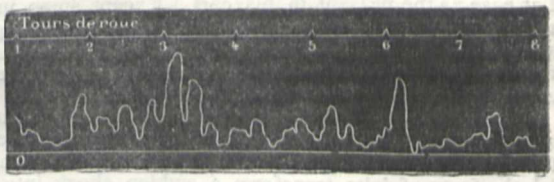

FIG. 4.—Tracing of the dynamograph for a hand-barrow drawn by a rigid trace.

the shocks. But it is not the ordinary dynamometer which I have used in my experiments, but a special dynamometer which undergoes under the strongest tractions only an almost insignificant elongation. This elongation, amplified by certain organs and transmitted to a distance by a lever fitted with a pen, is recorded in the form of a wavy curve in conditions referred to above. To sum up, in the employment of animated motors for the drawing of burdens, to find out wherever they produce shocks and vibrations, and to absorb them in elastic springs which restores to useful work a force that seemed only to destroy vehicles, tear up the roads, cause the animals to suffer—such is the direction in which much progress has been realised, and much more may still be realised.

2. *Of the Speed of Animated Motors.*—I shall per-

haps astonish many of you by saying that the speed of a vehicle is one of the things most imperfectly known. It is generally believed to be sufficiently expressed by stating how much way has been made and how much time has been occupied for that. I have come, you may say, from the Pont de Sèvres to the Madeleine in 41¼ minutes; the road is well mile-stoned, I possess a good watch; what greater precision do you require? Assuredly you have measured accurately the space traversed and the time employed, but that constitutes only the expression of a mean speed resulting from a series of variable speeds, of accelerations, of retardations, and sometimes of stoppages

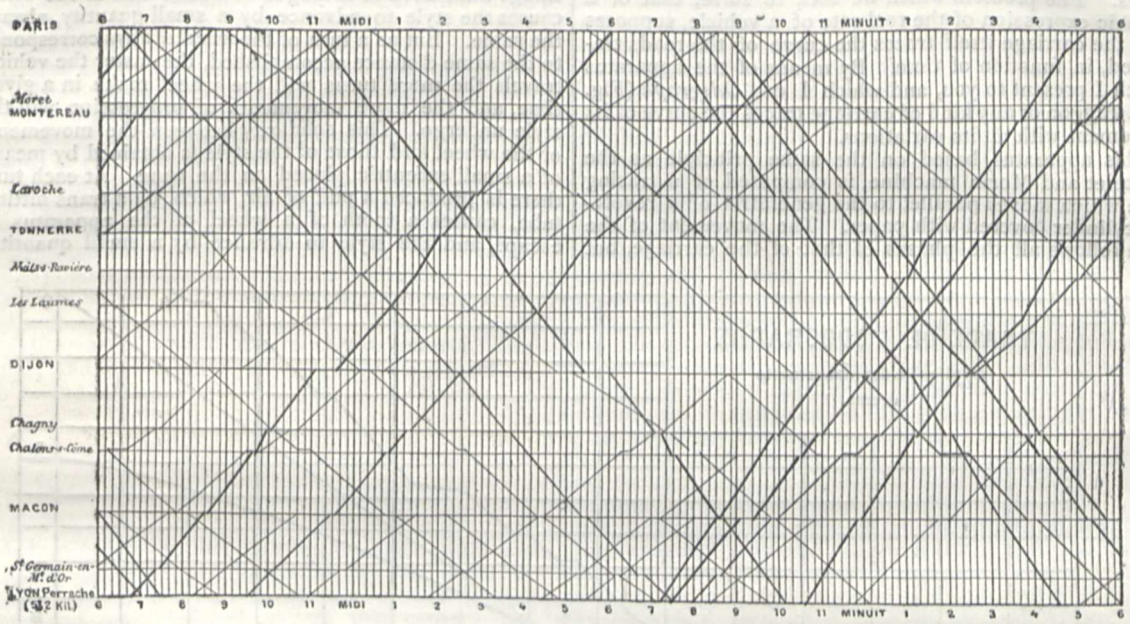

FIG. 5.—Graphic of the progress of trains upon a railway, after Ibry's method.—When we place the figure before us we read from the left, on the axis of the ordinates, the series of stations, that is, the divisions to be run over; the distance between the stations on the paper is proportional to the kilometric distances which separate them. In the horizontal direction, that is, on the axis of the abscissæ, are counted the divisions of time in hours, themselves subdivided into spaces of ten minutes each. The breadth of the table is such that the twenty-four hours of the day are represented on it, commencing at 6 A.M., and ending next day at the same hour. If we wish to express that a train is on a certain point of the line at a certain hour, we shall point out its position on the table, opposite the station or any point of the line which it occupies and on the properly chosen division of time. A single point of the table satisfies these conditions. At successive instants the train will occupy points on the table always different; the series of these points will give rise to a line which will be descending and oblique from left to right for trains coming from Paris, while it will be ascending and oblique in the same direction for trains going to Paris. The line which corresponds to each of the trains expresses the hours of departure and arrival, the relative and absolute rates of the trains, the instant of passing each of the stations, and the duration of stoppages. In fact, if we consider any particular train, we see that a train starts from the station at Paris at 11 A.M.; if we follow this train in its progress, we find that it has seven stoppages (during which it is not displaced in space, but only in time). These stoppages are translated by the horizontal direction of the line, opposite the station where they take place; the length of this horizontal line measures the duration of the stoppages. The line of the train, followed to the end, shows that the arrival takes place at 6 P.M.; but, if we reckon the distance on the axis of the ordinates, we see that 512 kilometres have been traversed in eleven hours ten minutes, stoppages included, which gives a mean rate of about 46 kilometres per hour.

where time is quite unknown. A rigorous measurement of rates supposes the road traversed by the vehicle at each instant; in other words, the position which it occupies upon the road. It is thus that physicists have determined the accelerated motion of the fall of bodies—Galileo and Atwood, by means of successive measurements, Poncelet and Morin by means of that admirable apparatus which traces by a single stroke the curve of a movement.

This machine is now too well known to need description; however, I shall make it work before you in order to interpret its language and to show how a graphic curve translates all the phases of a movement. The parabolic curve traced expresses for each of its points the position in which the body is found at each of the instants of its fall; it thus supplies the most complete information on the nature of the movement. But if, knowing only the space run over and the time employed, we join the two extreme points of departure and arrival by a straight line, that line, which will express the mean rate of the fall, will not correspond to any of the rates which the body has successively possessed.

The expression of movement by a curve has been put into practice. An engineer named Ibry has devised a method of representing graphically the progress of trains upon a railway. This mode of representation, incomparably more explicit than the tables of figures of our railway *indicators*, has not yet got into the hands of the public; and this is to be regretted, for it gives a genuine interest to a journey, as you may see by inspection of one of these graphics.

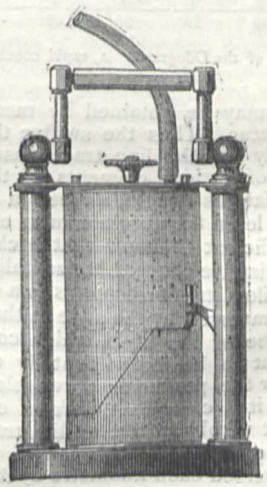

FIG. 6.—Odograph, reduced to one-third of its diameter.

The table which you see (Fig. 5) is prepared by engineers according to the regulation progress of trains

a progress supposed uniform; we see, in fact, that the lines of progress are all straight, joining to each other the two points which express the place and time of departure, the place and time of arrival. It does not then take into account the real movement of the train, which is accelerated or retarded under a great number of influences. The problem which we seek to solve, that of a graphic expression of the real rate of a vehicle, supposes that the carriage itself traces the curve of the roads traversed, in function of time. By means of the apparatus which I present to you, and which I call *Odograph* (Fig. 6), a waggon or any kind of carriage traces the curve of its movement with all its variations.

This apparatus, based on the same principle as the Poncelet and Morin machine, is composed of a tracing style which moves parallel to the generatrix of a revolving cylinder covered with paper. The movement of the style follows all the phases of that of the carriage, but on a very reduced scale, in order that the tracing of a distance of several myriametres may be contained in the dimensions of a sheet of paper. As to the movement of the cylinder, it is uniform, and commanded by clockwork placed in the interior. In order that the movement of the style may be proportional to that of the vehicle, things have been so arranged that each turn of the wheel causes the style to advance by a small quantity, always the same. But as a turn of the wheel always corresponds to the same distance accomplished, the faster the vehicle travels the more turns will the wheel make in a given time, and the more movements of progression will the style undergo. This solidarity between the movements of the wheel and those of the style is obtained by means of a small excentric placed on the vane. At each turn there is produced a puff of air, which, by a transmitting tube, causes a tooth of a wheel of the apparatus to escape, and the style to advance by a small quantity.

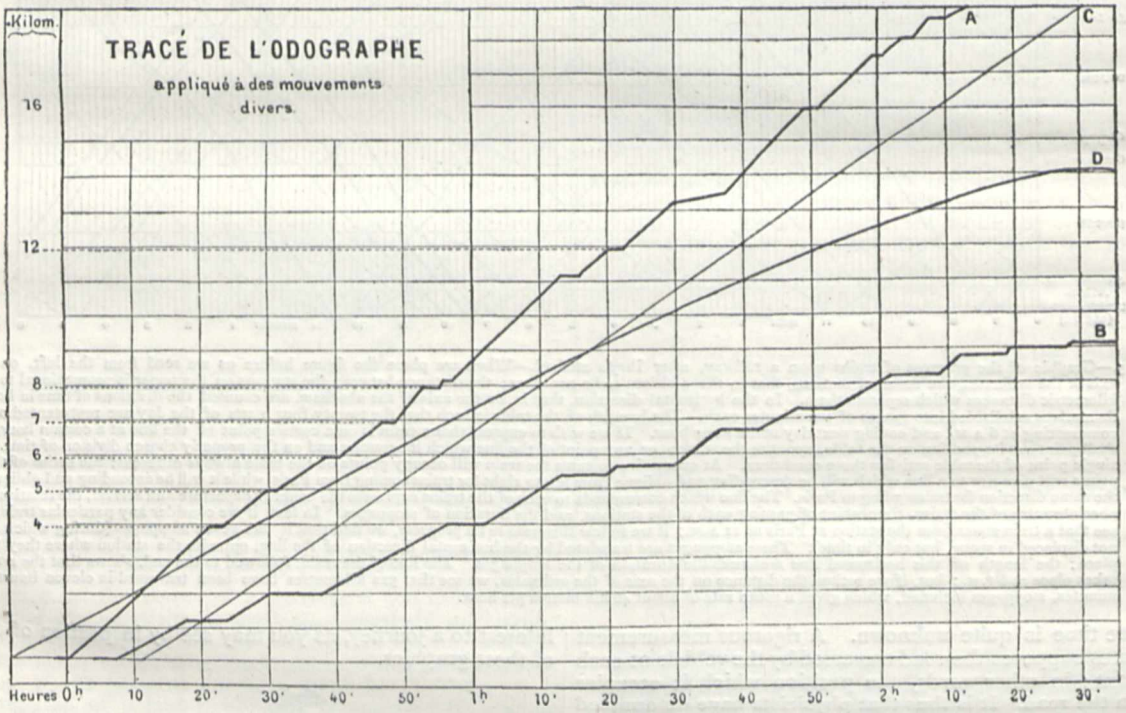

FIG. 7.—Tracings of the Odograph. A, rapid coach with stoppage; B, slow coach; C, gas meter, frequency of turns of the wheel; D, curve of the turns of a clock wheel-work with fly.

Similar effects may be obtained by means of electro-magnetic apparatus. Thus the swifter the vehicle goes the more rapidly will the line traced ascend; the comparative slope of various elements of the tracing will express the variations of rate, as seen in Fig. 7.

If we wish to learn the absolute value of time and distance, it is sufficient to know that each minute corresponds to a millimetre counted horizontally on the paper, and that each kilometre corresponds to a certain number of millimetres traversed by the style in the vertical direction. The course of the style, which corresponds to a kilometre, ought to be experimentally determined for each vehicle, for the perimeter of wheels is not always the same. But it is clear that, if from each kilometre-stone to another we obtain five millimetres, for example, for the course of the style, this length will always be found to be traversed each kilometre by the same vehicle. Our apparatus is then a measurer of distances, and dispenses with the necessity of attending to the existence of kilometre-stones; it enables the distance traversed on any road whatever to be estimated, and even when there is no beaten track. Thus in a journey of discovery we may measure the distance traversed by a cart. To remain in the conditions of ordinary life, have we not sometimes, in the country, a choice of two or three roads to go from one place to another? To know which is the shortest, we appeal to the watch, as if the least duration of a walk corresponded to the least distance. The odograph will give in this respect very precise information.

There is again a great number of questions which we ask daily without being able to solve them. Does such a draught horse go quicker than such another? Does this trot better to-day than yesterday? By increasing the ration of oats do we increase speed? Compare the slope of two curves of rates, and you will have the reply to all these questions without being obliged to make special experiments on a measured road, watch in hand.

It is not only to the speed of vehicles that the registering apparatus applies; it traces, though with less precision, the rate of progress of men and animals. We

slip into our boots a bellows sole, which is connected by a tube with a portable odograph. Each pace impresses on the style a small movement, as does each turn of the wheel of a carriage; and if the paces be absolutely equal, we may measure with certainty the distances travelled. In walking on level ground we take steps of astonishing regularity; but if the ground rises, the step gains in length; in descents, on the contrary, the steps are shortened. There may result from this slight errors in the distances traversed. Notwithstanding this, the employment of this apparatus will effect a great progress; it may be substituted with many advantages for the pedometer, which gives, at the end of a certain time, only the paces accomplished, without taking count of the stoppages or the changes of rate.

In short, when we make an experiment on a measured road, if there are produced variations in the length of the tracing represented by a kilometre, we conclude therefrom variations in the length of the pace. Such variations are observed under the influence of the slope of the country, the nature of the soil, the boots we wear, the rate of walking, or the weight carried. These studies in applied physiology have, I believe, a great practical importance, and numerous applications to the march of troops in a campaign.

(*To be continued.*)

WILLIAM KINGDON CLIFFORD

IT was with feelings of the deepest regret that we last week recorded the sad loss the scientific world and the country at large had sustained by the death, at the early age of thirty-three, of one of the deepest thinkers and most brilliant writers this century has seen. W. K. Clifford was the eldest son of the late Mr. William Clifford, J.P., of Exeter, and was born on May 4, 1845. Receiving his earlier education at the school of Mr. Templeton of that city, he proceeded to King's College, London. Here he at once gave evidence of his great powers by obtaining in his first year, 1861, the Junior Mathematical and Junior Classical Scholarships, as well as the Divinity prize. In the two succeeding years he gained the Classical and Mathematical Scholarships of the year, and in addition to the Inglis Scholarship for English language an extra prize for the English essay. Even at this time, whilst pursuing with such success so many branches of study, he sought a more genial occupation for his active mind in constantly reading in the college library the higher mathematical works to which he could obtain access, and towards the end of his school life, as also during his time as an undergraduate at Cambridge, he took great delight in solving and propounding problems in the *Educational Times*. While still in his eighteenth year the "Analogues of Pascal's Theorem" was written, and constitutes the first of his papers recorded in the Royal Society Catalogue. Passing from his school life, we find him entered at Trinity College, Cambridge, securing a Foundation Scholarship, college prizes in each academic year, and the English Declamation prize. Early in his career at the University he read such portions of the Tripos subjects as possessed any interest for him, and soon turned his attention to the study of the original writings of Sylvester, Cayley, Salmon, and some of the great Continental masters. In vain did his private tutor, the Rev. Percival Frost, who always had the highest admiration for him, and was anxious that he should attain his proper place in the Mathematical Tripos, urge him to devote a little more attention to examination subjects; his mind could tolerate no such restraint; nothing but the fresh and original thoughts of the greatest mathematical writers could satisfy his wants

His neglect of the examination subjects was such that it is said he only once wrote out a paper of bookwork questions, and that under the impression that he was solving problems; many also, well qualified to judge, were agreeably surprised when he obtained the position of second Wrangler in the Mathematical Tripos of 1867, while his success in obtaining the second Smith's prize was doubtless anticipated from the wider scope for his talents afforded by that examination. During this period the course of his future work is clearly seen; divinity and classics, at one time so ardently studied, are laid aside, and the writings of the great philosophers divide his attention with the study of higher geometry. One of his longest and most fully worked out papers, "Analytical Metrics," published subsequently in the *Quarterly Journal of Mathematics*, was written at this time, 1864.

Of the circle of intimate friends Clifford formed at this time, nothing need here be said; two or three have gone before him, the remainder have watched with the deepest interest and pleasure his widening reputation and growing influence, and are now left with a blank no one can fill, and all bear in affectionate remembrance his ready sympathy, delicate sense of humour, and sweetness of disposition. His success in the Trinity Declamation prize, and his popularity in the debates at the Cambridge Union Society, showed him to be a speaker of no common order, but it was not until he delivered his first Friday evening lecture at the Royal Institution of London, the year after he took his degree, and subsequently at the Sunday Lecture Society, that crowded audiences bore testimony to his extraordinary power of lucid exposition. The Royal Institution lecture, "On some of the Conditions of Mental Development," delivered March 6, 1867, was the first time he addressed a large public audience, which included many of the leading thinkers of the time, and from that day he took a recognised position amongst them. A short extract from this lecture reflects the habit of his mind on leaving the University, and indicates plainly that the course of study pursued while an undergraduate, probably by many thought misguided, was, in reality, the expression of a deep inward conviction. Speaking of the mind, he says, "still less must it tremble before the conventionalism of one age, when its mission may be to form the whole life of the age succeeding. No amount of erudition, or technical skill, or critical power, can absolve the mind from the necessity of creating, if it would grow. . . . The first condition of mental development, then, is that the attitude of the mind should be creative, rather than acquisitive;" and again, "It is quite possible for conventional rules of action, and conventional habits of thought to get such power that progress is impossible." Two other Friday evening lectures were given later by Clifford, on "Theories of the Physical Forces," Feb. 18, 1870; and on "Babbage's Calculating Machines," May 24, 1872; in the latter case no pains were spared by him to thoroughly master all the mechanical details of those intricate machines, and for years afterwards he would occasionally discuss schemes for the completion of the analytical engine. In public lecturing his greatest success was probably the evening lecture at the meeting of the British Association at Brighton, August, 1872, "On the Aims and Instruments of Scientific Thought." Throughout this lecture the key-note of so much of Clifford's most powerful writing can readily be detected, as may be shown by a short extract:—"If you will allow me to define a reasonable question as one which is asked in terms of ideas justified by previous experience, without itself contradicting that experience, then we may say as the result of our investigation, that to every reasonable question there is an intelligible answer, which either we or posterity may know. . . . By scientific thought we mean the application of past experience to new circumstances, by means of an observed order of events. . . . Remember then that it (scientific thought) is the guide of action; that the truth which it arrives at is not that which

we can ideally contemplate without error, but that which we may act upon without fear; and you cannot fail to see that scientific thought is not an accompaniment or condition of human progress, but human progress itself."

Several lectures delivered at St. George's Hall for the Sunday Lecture Society, such as those on "Ether," "Atoms," the "Sun's Place in the Universe," were all characterised by his extraordinary power of explaining some of the most difficult physical conceptions to a popular audience, and were invariably listened to with the greatest attention and pleasure. In his numerous contributions to the *Fortnightly*, *Contemporary*, and *Nineteenth Century Reviews*, his outspoken earnestness of purpose plainly showed the conscientious conviction of the writer, and riveted the attention of his readers even where they failed to convince. As many years secretary and afterwards a vice-president of the Mathematical and Physical Section of the British Association, he read many short original papers on mathematical subjects at the meetings, but it is to be regretted that no record of most of these remains. In the last few months of his active work, Clifford published the first part of a text-book he had long contemplated, entitled the "Elements of Dynamic." Bursting the bonds of the old method of treatment of the subject by the cumbrous rectangular coordinates, which had been so uncongenial to him in his college days, he draws the student lightly and softly into the toils of quaternions, thus almost imperceptibly introducing this simple and powerful method of analysis; sad it is indeed that his failing health did not allow him to complete this work which would have long remained as a valuable record of his method of teaching. Soon after taking his degree he was elected to a fellowship at Trinity College, and filled the post of assistant-tutor until his election to the chair of Applied Mathematics and Mechanics at University College, London, in August, 1871, which he held until his death. He was elected a Fellow of the Royal Society, June, 1874.

A critical examination of the value of his mathematical labours cannot be attempted; few, indeed, could do justice to them; but it is to be hoped that it may not long remain undone. All that can be said in concluding this brief sketch of his short and brilliant life is to give expression to the regret so widely felt that it was so prematurely cut off. He was—some of his friends may think unfortunately—most generally known for his philosophical and polemical writings. That his fame will rest on no such narrow basis, the following list of papers from the Royal Society Catalogue abundantly testifies:—

1. "Analogues of Pascal's Theorem" (January, 1863), *Quart. Journ. Math.*, vi. 1863, p. 216.
2. "Jacobians and Polar Opposites," *Messenger Math.*, ii. 1864, p. 229.
3. "Analytical Metrics," August 30, 1864, *Quart. Journ. Math.*, vii. 1866, p. 54; viii. 1867, pp. 16, 119.
4. "On the Principal Axes of a Rigid Body," *Messenger Math.*, iv. 1868, p. 78.
5. "On the Theory of Distance," Brit. Assoc. Report, 1869, p. 9.
6. "On the General Theory of Anharmonics," Lond. Math. Soc., ii. 1869, p. 3.
7. "On a Generalisation of the Theory of Polars" (1868), Lond. Math. Soc., ii. 1869, p. 116.
8. "On some of the Conditions of Mental Development" (1868), Roy. Inst., v. 1869, p. 311.
9. "On Syzygetic Relations among the Powers of Linear Quantics" (1869), Lond. Math. Soc., iii. 1869-71, p. 9.
10. "On a Case of Evaporation in the Order of a Resultant" (1870), Lond. Math. Soc., iii. p. 80.
11. "On a Cononical Form of Spherical Harmonics," Brit. Assoc. Report, 1871, p. 10.
12. "Synthetic Proof of Miquel's Theorem," *Messenger Math.*, v. 1871, p. 124.
13. "On a Theorem Relating to Polyhedra Analogous to Mr. Cotterill's Theorem on Plane Polygons" (1872), Lond. Math. Soc., iv. 1871, p. 178.
14. "Geometry on an Ellipsoid" (1872), Lond. Math. Soc., iv. 1871, p. 215.
15. "Preliminary Sketch of Biquaternions," Lond. Math. Soc., iv. 1873, p. 381.
16. "On Mr. Spottiswoode's Contact Problems," Roy. Soc. *Proc.*, xxi. 1873, p. 425.
17. "Graphic Representation of the Harmonic Components of a Periodic Motion" (1873), *Messenger Math.*, iii. 1874, p. 153.

DAVID PAGE

FEW names have been more familiar to general readers in geology than that of this practised writer. Born in Fife, his early years were spent in literary work of an unambitious kind. Among other occupations he edited for a time a newspaper in his native county. There used to be a story told of his having temporarily edited also the opposition paper during its editor's absence, and having carried on a most lively warfare in the rival pages. Whether well-founded or not, the story shows the estimation in which he was held as a facile writer. He afterwards entered into the employment of Messrs. W. and R. Chambers, and for some years took an active part in the preparation of their comprehensive series of educational publications. It was while in this capacity that he wrote his first introductory text-book of geology—a little volume which had a large sale and proved singularly useful in diffusing an elementary knowledge of the science. It was also during Page's connection with the Messrs. Chambers that the celebrated "Vestiges of the Natural History of the Creation" appeared anonymously. Looking back upon this now half-forgotten and superseded volume, it is hardly credible that it should have excited such keen feeling and passionate controversy. Having been the production of more pens than one, it was never formally owned by any one of its several authors. Robert Chambers was always credited with the lion's share of it, but there can be little doubt that he had powerful assistance from Page.

Quitting the service of Messrs. Chambers, Mr. Page embarked on a career of successful authorship. He rewrote his "Introductory Text-Book of Geology," and prepared an Advanced Text-Book on the same science. He likewise published manuals on Physical Geography, and from time to time issued various popular works on geological subjects. These were always well written. He had little original power as an observer, though some of his work, particularly among the crustaceans and fishes of the Upper Silurian and Lower Old Red Sandstones, shows considerable acumen, and raises a surprise that he should not have done more in that department. His great merit—and it is one which professed students in science, immersed in their own original inquiries, are apt to overlook and undervalue—was that he had the power of seizing on the leading features of scientific progress and discovery, and presenting them clearly and vividly before non-scientific readers. He has done good service in widening the circle of sympathy with research, and for this chiefly he deserves to be gratefully remembered by geologists. On the establishment of the Newcastle College of Physical Science, in connection with Durham University, he was chosen to lecture on geology. He had already, however, had premonitions of the paralytic affection which has at last proved fatal. He was eventually relieved of the duties of practically instructing his students in the field, this part of the work of the college being undertaken by Mr. Lebour. His failing health has for several years prevented him from appearing at the meetings of the British Association and elsewhere, as was his wont. He has at last been removed from among us in his sixty-fifth year.

NOTES

FIFTY-THREE candidates for the Fellowship are "up" at the Royal Society.

THE sum proposed in the Civil Service Estimates to be spent on the main fabric of the new Natural History Museum at South Kensington during the next financial year is 47,476*l.*, being the balance of a sum of 409,466*l.*, the "revise estimate" of the total cost of the erection of the building. It is also proposed to spend 20,000*l.* on "internal fittings." From the reply lately given in the House of Commons to Lord Arthur Russell, it seems that the Botanical and Mineralogical Departments will be transferred into the new building before the close of the year.

AT a meeting on March 7 at Cambridge of the general committee of the Darwin Memorial Fund, to decide whether the memorial should assume the form of a bust or a picture, and to select either the sculptor or painter willing to execute such memorial, it was stated that the funds promised amounted to over 400*l.*, which sum would be sufficient to procure either a bust or a picture. After some discussion it was resolved by a large majority that the memorial should take the form of a picture, and Mr. W. M. Richmond was selected as the artist to execute the same.

WE are informed that the committee appointed to receive subscriptions for presenting a bust of Mr. Wm. Spottiswoode, P.R.S., to the Royal Institution, as a testimonial of his valuable services as its treasurer and secretary successively, have engaged Mr. Richard Belt as the sculptor.

SINCE Parliament reassembled the finest example of practical telegraphy that has probably ever been witnessed has been going on between London and Ireland. Two news wires have been worked simultaneously and continuously between London, Dublin, Cork, Belfast, and Londonderry at the unprecedented speed of 130 words per minute. The Post Office authorities have recently been making very great improvements in their fast speed apparatus. The forthcoming International Conference and the success of the American quadruplex system are probably stirring them up to maintain their pre-eminence in this field. England cannot run second to any nation in telegraphy.

WE are greatly disappointed and much surprised to learn that the application of the Scottish Meteorological Society for assistance to establish an observatory on Ben Nevis has been rejected both by the Meteorological Council, with its yearly 15,000*l.*, and the Government Grant Committee, with its 5,000*l.* The former had other matters to attend to, the latter handed the application over to the Council of the Royal Society, labelled "highly commendable." We have recently shown our readers with what heartiness and cosmopolitanism such nationally beneficial undertakings are managed in France; yet in this disgracefully wealthy country, with 15,000*l.* a year expressly devoted to meteorology, a plan of promoting meteorological research that would lead to results of the highest consequence must collapse for want of a paltry 500*l.* to start it. It would be a shame if so really national an enterprise were to depend entirely on private subscription.

MR. MONCURE CONWAY proposes to hold a "Memorial Service" on the late Prof. W. K. Clifford at South Place Chapel, Finsbury, on Sunday morning next. After the service, Mr. Conway will deliver a discourse, taking Prof. Clifford for his subject.

IT is stated that the Botanical Exchange Club will have to be dissolved after the next distribution, in consequence of the difficulty of finding any one with the requisite critical knowledge of British plants and the leisure to enable him to perform the duties of curator. The club has been of great service in furnishing a medium of intercommunication between British botanists; and the annual reports of the curator have frequently been essays of considerable value. It is greatly to be lamented that one result of the increasing attention paid by botanists to the physiological side of the science should be the discontinuance of so useful an institution.

AT the annual meeting of the Geological Society, the Wollaston gold medal was awarded to Prof. Bernard Studer, "the father of Swiss geology;" the Murchison medal to Prof M'Coy, of Melbourne; the Lyell medal to Prof. E. Hébert, of Paris: the Bigsly medal to Prof. E. D. Cope, of Philadelphia; the balance of the Wollaston Donation Fund to Mr. Samuel Allport; the proceeds of the Murchison Geological Fund to Mr. J. W. Kirkby; a moiety of the balance of the proceeds of the Lyell Fund to Prof. Alleyne Nicholson, and the other moiety to Dr. Henry Woodward, F.R.S.

IT is stated that Capt. Sir George Nares, K.C.B., has been appointed to be the chief of the Harbour and Marine Department of the Board of Trade, in succession to Rear-Admiral Bedford. Sir G. Nares is now in command of Her Majesty's ship *Alert*, which is on a scientific cruise in the Straits of Magellan. Capt. J. F. L. P. Maclear has been appointed to the *Alert*.

A COMMITTEE has been organised to obtain subscriptions for erecting a statue to Nicephore Niepce, the inventor of photography. A circular has been published and will be sent to all scientific societies over the world.

THE movement for the propagation of electric lighting in Paris has not abated. A new paper entitled *La Lumière électrique* will be started in a few days under the editorship of M. de Parville. M. Regnier, the inventor of a lamp working by contact will begin experiments at Breguet's workshop. M. Ducretet is busy with his new lamp with a floating positive-carbon in mercury, and the Alliance Company will try Werdermann's on a large scale. The gas company and Jablochkoff are preparing to illuminate the spaces which have been allotted to them. Although the scientific question may be considered settled except under improved electrical conditions the Paris electricians are sanguine that the final verdict will not be given against the electric light.

THE experiments with the electric light recently made in the reading-room of the British Museum have satisfied the trustees of its applicability for the purposes of the room as far as the amount and distribution of light are concerned, although the full number of lamps was not employed. On three occasions the light was turned on at dusk, in order to enable readers to continue their studies without interruption for another hour. As far as could be ascertained they were enabled to work by it without difficulty, even at the tables where the light was weakest. The experiments are discontinued for the present, but a further trial of the light will probably be made some months hence, with the view to utilise it on dark days, and for extending the hours for using the reading-room in the winter.

THE Report by the Regius Keeper of the Edinburgh Botanic Garden for 1878 complains of the want of accommodation in various ways, and of the insufficiency of the present grant. These complaints are not now made for the first time, and we trust they will meet with speedy attention in the proper quarter.

RECENT explorations of the lake-dwellings of the Lake of Geneva prove that they were destroyed by fire during a spring, when the waters of the lake stood at the same level as now. A layer of charcoal from the burnt dwellings is to be found along the whole coast, beneath a layer of sand and gravel.

REMAINS of lake dwellings of the highest scientific interest have been discovered by members of the Donaueschingen Historical Society under the guidance of Dr. B. Spuren. The

dwellings are situated in the so-called Pfohrener Ried, near Donaueschingen. Numerous objects have been brought to light, such as remains of textures, and implements dating from the stone, bronze, and iron ages.

IN the present year the eighteen centuries will be complete, which have elapsed since Pompeii, Herculaneum, and some neighbouring cities were destroyed by a rain of ashes and torrents of lava from Mount Vesuvius. The directors of the excavations at Pompeii intend to commemorate the event in a scientific manner in November next, and have issued invitations to the most eminent Italian archæologists to participate in the celebration.

DURING the night of January 7-8, an earthquake was felt at Alaghir, Caucasus; it consisted of five shocks which had a direction from north to south. An earthquake visited Laibach on February 12. Two severe shocks were felt at 2.42 P.M. within about three or four seconds. The phenomenon was observed in the whole of Carniola and Lower Styria, also in some part of Carinthia and at Trieste. The direction of the undulations was from south to north, and they were preceded by loud subterranean noise; their duration was about five seconds. It is remarkable that this earthquake was observed in Southern Austria on the same day, as one of the Teplitz sources ceased to flow. On February 14, at 2.45 P.M., more shocks were observed at Laibach and Krainburg, but they were extremely weak. Subterranean shocks were also felt at Riva on the Lake of Garda on February 14, as well as at Bischofslaak in Carniola on February 16.

A REMARKABLE phenomenon is reported from Neufchatel. On February 10 the Lake of Neufchatel suddenly assumed a motion like the sea with its tides, only with the difference that the rise and fall of the water succeeded each other in much shorter intervals. The phenomenon began at noon and lasted until 2 P.M. Boys who were playing on the shore were so suddenly surprised by the rising lake that they were up to their knees in water before they had time to escape. In the evening there was a violent thunderstorm, which also visited Berne at the same time.

ROMAN antiquities have been recently discovered in the open space in front of the Votive Church at Vienna. The space is in course of transformation into a public garden. Among the objects found are some rare coins, toga clasps, urns, as well as the remains of tombs and of a bath.

IN the basin of the Teplitz Stadtbad, the recent stoppage of which has caused so much alarm in the charming Austrian watering-place, Roman coins and antiquities have been found. On one of the coins a female bust is represented with the circumscription "Sabina Augusta" (wife of the Emperor Hadrian, A.D. 117-138). The source must therefore have been well known to the Romans, and it is quite possible that even before the year 762, when it is first mentioned in Bohemian history, it may have temporarily ceased to flow. Besides the Roman coins, Bohemian and German coins (up to the year 1740) were discovered.

THE *China Overland Trade Report* mentions that a scheme is about to be carried out for establishing a woollen manufactory at Lanchow-fu, in North-Western China. Though Kansuh, the province of which it is the capital, is not populous, the locality has been chosen on account of raw material being plentiful in the neighbourhood. Machinery is said to have been already shipped from Europe, and two German gentlemen have been engaged to superintend the preliminary operations and to start the enterprise.

AT the last meeting of the St. Petersburg Society of Russian Naturalists, M. Grimm made a very interesting communication on the crustaceans of the Caspian Sea. The crustacean fauna of that sea has some likeness with the faunas of Lakes Baikal and Titikaki, especially as to the richness of both in amphipods, and as to the nearly total want of decapods. But the likeness is closer with the faunas of the European lakes, as well as with the faunas of the Black Sea, and yet more, with the Arctic Ocean and Lake Aral. Altogether, the study of the Caspian crustaceans proves that at a recent epoch the Caspian Sea was in connection with these lakes and seas, and that the connection of the Caspian with the Arctic Ocean and Lake Aral continued until a more recent period than the connection with the Black Sea.

AT the same meeting Prof. Bogdanoff proposed to the Society to undertake the publication of a work comprising all trustworthy data about the ornithology of the northern parts of Russia in Europe. The proposal met with great approval, and a commission consisting of MM. Bogdanoff, Polyakoff, Pleske, and Keppen, was appointed for the preparation of the said work.

AT the last meeting of the Paris Geographical Society, a communication was read by M. Sconzac, a French officer, belonging to the Chinese service on the origin and propagation of the Russian plague. The lecturer contended that this epidemic originated in the province of Yunan, and was carried by travellers *viâ* Mesopotamia. The lecture will be published *in extenso* in the Society's *Bulletin*.

A VERY satisfactory report was presented at the recent annual meeting of the Royal Microscopical Society, which has now been in existence forty years. The members number 437, and the funds are in a flourishing state.

VOL. VII., part 1, of the *Proceedings* of the Yorkshire Geological and Polytechnic Society contains a number of important papers on local geology, and one or two of more general interest.

IN the just issued number of the *Proceedings* of the Geologists' Association is the continuation of Mr. W. H. Huddleston's valuable paper on the Yorkshire oolites, while Prof. Bonney contributes some interesting observations on the igneous rocks of Arthur's Seat.

M. FERRY, the new French Minister of Public Instruction, has visited the Sorbonne, the School of Medicine, and other buildings devoted to science, for the purpose of deciding what repairs must be done immediately.

THE Swiss Palæontological Society has just published the fifth volume of its *Abhandlungen*, which contains several valuable papers. Prof. Rütimeyer gives the conclusion of his most interesting researches into the deer of the tertiary period. Prof. P. de Loriol continues his researches into the Swiss fossil crinoids, and gives the conclusion of a very valuable monograph on the fossils of the Baden formation, a subdivision of the recent Jura formation. Dr. Wiedenheim publishes for the first time a complete description of the *Labyrintodon rütimeyeri*, discovered in 1864 in the sandstone of Rieben, at Basel, and M. J. Bachmann describes the fossil eggs from the neighbourhood of Lucerne. Twenty-five fine coloured plates illustrate the papers. The Society was founded in 1874, with statutes and aims much like those of the British Palæontological Society, especially for the study of Swiss palæontology; and the five volumes already published by the Society contain a great diversity of very valuable papers by Professors Rütimeyer, in Basel, De Loriol, in Geneva, and Renevier, in Lausanne.

THE Swiss meteorological stations have adopted a system of weather warnings. All the territory of Switzerland will be divided for that purpose into eight regions, each of which will have its central station. The information on the state of weather

in Europe, received at these stations, will be graphically represented on maps, and these maps will be exhibited between four and five P.M. at a central point of the town, under glass, for public use. Besides there will be given a prognostic of weather for the following day; and this information will be sent to each commune and person who will pay monthly the sum of 15 francs. This system is already introduced in Zurich and Berne, and the prognostics are correct in eight cases out of ten.

WE have received from Mr. Downing, of Whiskin Street, a neat little cabinet of twenty specimens of rocks, fossils, and minerals to illustrate Geikie's *Geology Primer*. Considering the number and quality of the specimens, and their suitability for the purpose, the cabinet is a wonder of cheapness, and ought to have a wide sale.

IN view of the apparently insurmountable difficulties which attend the completion of the New National Opera House on the Victoria Embankment, the *Globe* understands that all the agents-general for the different colonies have entered into negotiations for the purpose of securing this site for the proposed Colonial Museum.

INTERESTING correspondence has appeared in the British Guiana *Royal Gazette*, we learn from the *Colonies and India*, relative to the qualities assigned to the fruit of the papau-tree. It has been recently asserted, in an article in the *Pharmaceutical Journal*, "that the most interesting property attributed to it is the power of its juice to render bad flesh tender." Mr. Monro, of Georgetown, furnishes certain facts which he says are commonly known to the natives of British Guiana relative to this fruit. A horse tied near one of these trees rapidly loses health, and a stud horse becomes useless. Any pressure on the body of the animal leaves an inelastic indentation. The sap of the tree will soften steel, and before the process of tempering was known in the Colony, the blacksmiths used to drive their brittle chisels and plane vices into the wood, leaving them there for a day or two; and tough meat wrapped in the leaf for only a few minutes becomes tender, and the same thing happens if it be suspended against the tree itself. The seed of the ripe fruit is an excellent vermifuge, and children have a great partiality for it.

IN a recent paper in the *Journal de Physique* complementary of the theory of dew, M. Jamin points out that moist surfaces are subject to two superposed causes of cooling, one radiation (like dry substances), the other evaporation. The difference between the two actions is that the former persists at every temperature, while the latter, at first considerable, decreases and becomes *nil* when saturation is reached (it does not produce dew, but contributes to prepare and accelerate it, for it renders the air both moister and colder). The quantity of heat borrowed from the air by evaporation is very considerable: 1 gramme of evaporated water lowers about one degree the temperature of 2,553 grammes of air (or nearly two square metres' volume). Thus is explained how moist bodies, like plants, especially herbaceous, are cooled much more quickly than dry bodies. The dew forms on them more quickly; once it has commenced it continues by the sole effect of radiation. In driving rapidly down from a plateau into a valley one is often struck with the sudden cold. This cold is probably the effect of more rapid evaporation from the herbs, aquatic plants, and all moist surfaces of the valley. Other facts illustrate the double effect of radiation and evaporation, *e.g.*, the danger of plants in early spring after being moistened by a shower, and the well-known mode of manufacture of ice in Bengal. The *rôle* of dew is that of moderating and sometimes arresting the nocturnal cooling, and preserving plants from the early frost.

AN interesting lecture on certain enigmatical phenomena of astronomy has been recently delivered by M. Houzeau before the Belgian Academy of Sciences, of which he is president. The points he takes up are, the apparent enlargement of heavenly bodies near the horizon (not adequately explained by a weakening of the rays, or interposition of terrestrial objects); the supposed satellite of Venus, observed seven times in 119 years, by eminent astronomers, but quite unobserved during the 114 years since; the phenomena connected with Biela's comet; the effects of the earth encountering a comet (may such a thing occur? has it occurred?); and the zodiacal light. The lecture appears in the Academy's *Bulletin* (No. 12 of 1878).

WE have on our table the following books:—"Text-Book of the Steam Engine," T. M. Goodeve (Crosby, Lockwood, and Co.); "The Aborigines of Victoria," 2 vols., R. Brough Smith (Trübner); "Report of the British Association for the Advancement of Science, 1878," Dublin (Murray); "The Circle and Straight Line," John Harris (Wertheimer, Lea, and Co.); "Moore's Columbarium," reprinted by W. B. Tegetmeier (*Field* Office); "Practical Treatise on the Manufacture of Sulphuric Acid," A. G. and C. G. Lock (Sampson Low and Co.); "Atlas of Histology," Part i., E. Klein and E. N. Smith (Smith, Elder, and Co.); "Geologische Uebersichtskarte des Tirolisch-Venetianischen Hochlandes zwischen Etsch und Piave," 6 Maps, Dr. Edmund Mojsisovics, (Vienna: A. Holden); "Die Dolomit-Riffe, von Sudtirol und Venetien," Heft i. to vi., E. V. Mojsisovics (Vienna: Alf. Holden); "Meteorological Observations made at the Adelaide Observatory, years 1876 and 1877," Ch. Todd; "Journey through Khorassan," 2 vols, Col. C. M. M'Gregor (Allen and Co.); "Lakes and Mountains of Africa," J. F. Elton (Murray); "On the Annelida Chætopoda of the Virginian Coast," H. E. Webster; "Fécondation des Fleurs," E. and G. Gevaert (G. Mayolez).

THE additions to the Zoological Society's Gardens during the past week include three Japanese Deer (*Cervus sika*) from Japan, presented by the Viscount Powerscourt, F.Z.S.; a Syrian Bear (*Ursus syriacus*) from West Asia, presented by Dr. J. Huntley; a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Miss E. A. B. Payton; a Pig-tailed Monkey (*Macacus nemestrinus*) from Java, presented by Mrs. J. E. Fenton; a Coati (*Nasua nasica*), an Acouchy (*Dasyprocta acouchy*) from British Guiana, two Mountain Finches (*Fringilla montifringilla*), British Isles, purchased.

SCIENCE IN RUSSIA

WE take from the just issued Annual Report of the St. Petersburg Academy of Sciences for 1878, the following information as to the work done by the Academy during the year in the mathematical and physical sciences.

Prof. Chebysheff has continued his researches into the properties of parallelograms which consist of three elements, and are symmetrical with respect to one axis, these researches already having led him to important results; among them we notice his general formula for determining what are the simplest combined systems which, when set in motion, give a straight line.

Prof. Minding has published two papers, one of which is an important addition to his former researches on curves.

The Pulkova Observatory has published the ninth volume of its Memoirs, which contains the micrometrical measurements of double stars by Prof. O. Struve, during forty consecutive years. The value of these very numerous and precise measurements is much increased by the circumstance that they were made during so long a period by the same person, with the same instruments, and on the same methods; the comparison of M. Struve's observations with those of several known astronomers affords a means of reducing all of them to one system.

The transit of Mercury was observed at Pulkova with fourteen telescopes. It is worthy of notice that the observations proved that Mercury does not have such a dense atmosphere as that discovered around Venus.

The interesting researches of the late Prof. Asten into the

motion of the comet of Encke were already well prized by all men of science. The *Memoirs* of the Academy contain this year a new work by Prof. Asten, on all the appearances of that comet from 1819 to 1875. M. Asten has published also new ephemerides of the comet for this year, and their precision was already proved by the numerous observations made in the southern hemisphere. Unhappily he could not see this brilliant confirmation of his researches, death having taken him from the ranks of men of science.

Prof. Bredikhine was engaged in very interesting researches into the tails of comets, and he established that there are three quite different kinds of tails, according to the different relations between the attractive and the dispersive force of the sun, which last is modified by the different properties of the particles of which the tail is formed. Spectral analysis will probably confirm this hypothesis.

As to spectral analysis in its application to heavenly bodies, the report states that it is not based, as yet, on sufficiently positive data, and that to elaborate these data with the accuracy usual to other astronomical observations, is the special aim of the astro-physical department of the Pulkova Observatory. Thus M. Hasselberg has published two works, one of which reduces the observations of Kirchhoff to wave-lengths, and the other deals with a precise description of the spectra of absorption of NO_2, and bromine. The same author has recently proved that the displacement of spectral lines does not depend upon the density of the gas.

Observations on the variations of luminosity of stars were pursued by M. Lindemann, who has added 42 other stars to the 280 variable stars, included in the catalogue of M. Sjölerup. Prof. Savitch has made observations on oppositions of planets and on the transit of Mercury. He has also read at the Academy a paper on corrections on the pendulum of Repsold. Finally, we notice the observations of M. Njuren on earthquakes, as noticed by vibration of the sensitive levels of astronomical instruments.

In physical science the report begins with the work of the Central Physical Observatory at St. Petersburg. The Director of the Observatory, Prof. Wild, has a memoir on the determination of the real temperature of the air by a thermometer, and on the precautions to be taken for avoiding various secondary influences on the instrument, especially those of radiation. Thermometers which allow the determination of the temperature of the air with a precision of one-tenth of degree, have already been introduced into Russian meteorological stations. Besides, Prof. Wild has proposed very satisfactory improvements in the siphon barometer which allow easily the transportation of the barometer dismounted, without changing its error, and thus afford a means for comparing with great accuracy the normal barometers of different stations. After having given, during the preceding years, special attention to terrestrial magnetism, the Central Physical Observatory has occupied itself with atmospheric pressure, and Capt. Rykatcheff has published a paper on the diurnal changes of barometrical pressure, based on the observations of eleven Russian and twenty-four foreign stations. The theory for explaining the diurnal changes of pressure, proposed by M. Rykatcheff, seems to be more probable than that of Dove, usually accepted until now. Among other meteorological papers, published by the Academy, there are worthy of notice those by Prof. Lenz, on the Galvanic Resistance of Solutions of Salts of Kalium, Natrium, and Ammonium; by Capt. Rykatcheff, on Winds on the Baltic; by M. Dorandt, on Anemometers; by M. Hellmann, on the Comparison of the Normal Barometers at St. Petersburg, Helsingfors, Dorpat, Stockholm, and Upsala; and by M. Stelling, on the Intensity of Day-Light at St. Petersburg.

In chemistry Prof. Menshutkin has continued his researches on the Influence of the Isomerism of Alcohols and Acids on the Formation of Compound Ethers; and the Report notices among the chemical papers which have appeared in the publications of the Academy, those by Mrs. Lermantoff, on the Influence of the Tertiary Sodic Butyl on Isobutylene, and by M. Paoloff and Jawein, on Organic Chemistry.

In geology the year 1878 is marked by the appearance of the most important work, by Prof. Frederick Schmidt, on Silurian Trilobites of the Eastern Coasts of the Baltic, being the result of twenty years' researches, and of a thorough comparison of Russian trilobites with those of other countries. The work will contain the description of about 140 species; the first fascicule, actually in the press, contains a general description of the silurian rocks in the governments of St. Petersburg and Esthonia. Prof. Meller has described the collections brought from the Manyeh by M. Danilcosky, and has proved the former extension of the Caspian very near to the Sea of Azov.

In botany the first place is occupied by the work on the Algæ of the White Sea, by M. Gobi. Prof. Famintzin has continued his researches into the embryology of plants, and by means of preparations made on the method of Nestermeyer, he has arrived at important results as to the formation of tissues in the embryons of plants. M. Klinge has made very interesting histological researches on roots of several Monocotyledons.

In zoology Prof. Brandt has published important additions to his former work (appeared in 1877) on the Rhinoceroses, living and extinct. But the most interesting of his works is certainly that on the Elasmotherium. Judging by the few teeth, found until now, of this extinct mammal, which formerly inhabited Europe from the Rhine to the Kirghiz Steppes, Prof. Brandt had described the elasmotherium as a form of the family of rhinoceros, but very near akin to the horse. A complete skull of this animal, which was recently found at Sarepta, on the Volga has quite confirmed the opinions of this zoologist. The elasmotherium is most nearly related to several kinds of rhinoceros, having at the same time several features common with the horse, and forms a separate sub-family of rhinoceros; he lived at the same time as the bison, the rhinoceros, tichorhinus and man. Prof. Kessler gives interesting descriptions of new fishes from Central Asia. M. Mereshkofsky has explored the sponges of the White Sea, and M. Boetger is publishing an important monograph on the *Clausiliæ*. Finally, the Report mentions the works of Prof. Ovsiannikoff on the anatomical structure of the cerebrum of the dolphin and other vertebrata, and the papers by Prof. Gruber, on variations of the muscles and the bones of man.

In the report of the historico-philological section of the Academy we mention the works of Prof. Dorn on inscriptions in the Pelegvian language and on the Semnan language, a now nearly extinct branch of the Iran branch; and memoirs, by Prof. Schiffner, on Buddhism; and by Prof. Wideman, on Finnish languages, namely, of that of Zyryans.

As to the premiums awarded by the Academy, those bearing Lomonosoff's name, for works in chemistry, physics, and mineralogy, and Buniakofsky's, for works in mathematics, were not awarded this year. A new premium, bearing the name of Helmersen, was founded this year for works in geology.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

PROF. JAMES STUART'S efforts to develop a school of Applied Science at Cambridge, have produced further fruit in the shape of a report of the Board of Mathematical Studies, recommending an alteration in the scheme of examination in mechanism and applied science for the ordinary B.A. degree. It is proposed now that papers on mechanics and on heat shall be obligatory on all candidates, while they shall choose one only of three other subjects, viz., (1) Mechanism. (2) Theory of Structure, Strength of Materials, and Principles of Surveying and Levelling. (3) Electricity and Magnetism. The examination is to be made as far as possible a satisfactory basis for a professional career by its practical character. Thus every candidate will be required to show his ability to write an accurate description or specification of an instrument, machine, or model exhibited, and to make a working sketch to scale. Evidence of actual capacity to use the tools or instruments belonging to the subject selected by the candidate will be demanded. The first class in the class list is to consist only of those who have distinguished themselves in one of the three alternative subjects. We do not doubt that it will soon be realized that a student who has to pass an examination in Greek and Latin in his second year will not have time to master his Science subjects by the end of the third. There will be much more chance of attracting students of Applied Science to Cambridge if they are excused from the classical portions of the "General" Examination for the ordinary degree.

IN the new scheme for the Classical Tripos at Cambridge, the advanced portion will include several groups of subjects, of which one only is to be selected by a candidate. Three of these groups are History, Archæology, and Language, and the knowledge and treatment required will be thoroughly scientific in character. Archæology will include papers on Greek and Roman

mythology and religion, on topography and monuments, and on art and handicraft and the inscriptions of the Greeks and Romans, in relation to their domestic and national life. The Language group will include elementary Sanskrit, the comparative grammar of the Indo-European languages, and the history of alphabets.

FORTUNATELY the demands of science are sometimes so urgent, that they cannot be resisted, as in the case of the School of human anatomy at Cambridge, which has so outgrown its accommodation that a new dissecting room must be immediately provided, pending the expected erection of really adequate buildings for the medical schools some years hence. There are sixty students dissecting this winter, under Dr. Creighton, and several assistant demonstrators. In the interests of health and education, a large room is to be built over the present lower rooms at a cost of 600*l.*, which will supply the pressing need of space.

IT is satisfactory to learn that physical science will be represented among the three representatives of Trinity College sitting with the Cambridge University Commissioners, by Mr. Trotter, who has taken a very influential part in framing the new statutes of his college, and that Prof. Bonney is one of the representatives of St. John's College. We wish that we might hear that other colleges sent equally accredited men of science to strengthen the cause of physical science before the commissioners.

A VACANCY having occurred in the professorship of botany at the University of Innsbruck by the transference of Kerner to the important chair at Vienna as successor to Fenzl, Dr. Peyritsch, director of the botanic garden at Vienna, has been appointed to the professorship at Innsbruck.

THE Zurich University has just granted the diploma of Doctor of Philosophy to Miss Helene Druschkovitsch, from Vienna, after a brilliant defence of her dissertation on the "Don Juan" of Byron.

THE Geneva University numbers 391 students, of whom 208 are not matriculated. Out of the 391 students 212 are Swiss, and the others are strangers; there are forty-five ladies, of whom five, Russian, are matriculated.

SCIENTIFIC SERIALS

Zeitschrift für wissenschaftliche Zoologie, vol. xxxii., part 1.—J. Brock on the sexual organs of cephalopoda, first memoir, dealing with sepia, loligo, sepiola, eledone, pp. 116, 4 plates. F. E. Schultze, researches on sponges, sixth part, the genus spongelia, 41 pp., 4 plates.—L. Löwe, on the anatomy of the gills of serpula, 30 pp., 1 plate.

Morphologisches Jahrbuch, vol. iv. part 4.—Contribution to the anatomy and histology of the sexual organs of osseous fishes, by J. Brock, Erlangen, 68 pages, describing very many forms, 2 plates, with figures from eleven genera.—The folds of the mucous membrane in the human palate, by C. Gegenbaur, with 1 plate, giving a comparison between the palatal markings of human fœtuses and those of the orang, cercopithecus, and ateles.—On the female sexual apparatus of *Echinorhynchus gigas*, by A. Andres, 1 plate.—The extensor muscles of the calf and foot of mammals, by G. Ruge, a very extensive inquiry, 52 pages, 4 plates, followed by another from the same author on the deep muscles of the sole of the foot, with 2 plates.—On *Labyrinthodon Rütimeyri*, by R. Wiedersheim.—On the homology of segmental organs in annelids and vertebrates, by Max Fürbringer.

Kosmos, November.—On Bacon of Verulam, the founder of modern realism, by Fritz Schultze.—The origin and evolution of sensory organs (eye and ear), by Ernst Haeckel.—Colour in animals and plants, by A. R. Wallace, translated from the English.—On the political constitution in primitive grades of culture, by M. Kulischer.—Report of the meeting of the German Anthropological Society.

December.—On the discovery of the soul, by G. Jäger.—Colour in animals and plants, by A. R. Wallace, concluded.—The elasmotherium of the diluvium.

January.—Philosophic reflections on the nebular hypothesis, by Carl du Prel.—The mathematical basis of the structure of the plant body, by Dr. S. Gunther.—Dissimilarity between the male and female of *Epicalia acontius* by Fritz Müller.—Primitive constitution; part 2, federation, by M. Kulischer.

THE *Bulletin de l'Académie impériale des Sciences de St. Pétersbourg* (t. xxx. No. 3) contains the following papers of interest:—On an application of the finite differential calculus, by F. Minding.—On some extraordinary muscles, tensores fasciæ suralis, in man, by Dr. W. Gruber.—On a new species of ossiculum supernumerarium carpi in man, by the same.—Palæontological observations regarding M. Danilewsky's journey to the Manytsch, by V. Möller.—Supplementary observations to a monograph of the *Rhinoceros tichorhinus*, by J. F. Brandt.—New researches on the ichthyology of Central Asia, by K. Kessler.—On the tail of comets, by M. Bredikhine.

THE *Sitzungsberichte* of the Vienna Academy of Sciences (Physical, Chemical, and Astronomical Section, vol. lxxvi. parts 2–5, vol. lxxvii. parts 1–3) contain the following papers of interest:—On some maxims and proofs of the theory of the resultant, by Dr. B. Igel.—On a relation corresponding to the linear differential equations of the second order, by Dr. A. Winckler.—Researches on the compounds of the camphor group, by J. Kachler.—On the state of heat equilibrium of a system of bodies with reference to gravitation, by J. Loschmidt.—On a new radiometer, by Dr. J. Puluj.—On the substances found in crude anthracene, by Dr. O. Zeidler.—On the behaviour of camphor towards chloral hydrate, by the same.—On the orbit of Loreley (165), by Dr. G. Gruss.—On the behaviour of acetylene towards concentrated sulphuric acid, by S. Zeisel.—Researches on the heat-conducting capacity of cotton, sheepswool, and silk, by J. Schuhmeister.—On the action of ammonia upon isatine, by Dr. E. von Sommaruga.—On idryl, by Dr. G. Goldschmiedt.—On the action of hydrochloric acid upon resorcine, by L. Barth and H. Weidel.—On the behaviour of certain resins and resinous acids when distilled over zinc dust, by G. Ciamician. On the smallest absolute number of sound impulses which is necessary for the production of a tone, by Prof. Pfaundler.—Report on Egger's electro-magnetic motor, by Prof. R. Handmann.—On the stand-aneroid-barometer, by Dr. Anton Schell.—On citramalic acid, by Th. Morawski.—On the temperature of Vienna, deduced from observations during a century, by Dr. J. Hann.—On a partial differential equation of the first order, by Dr. Franz Hocevar.—On the connection of n different straight lines in a plane, and certain other mathematical maxims, by S. Kantor.—On the magnitude and position of the optical elasticity axes in gypsum, by V. von Lang.—On mononitropyrocatechine, by Dr. R. Benedikt.—On some problems in the theory of elastic after-effects, and on a new method of observing oscillations by means of mirrors, without incumbering the oscillating body with a mirror of considerable mass, by Dr. L. Boltzmann.—On the orbit of Laurentia (162), by K. Zeller.—On the application of Doppler's principle on the progressing motion of luminous gas molecules, by Prof. Pfaundler.—On some mathematical maxims relating to cone projections, by E. Weyr.—On the chemical nature of peptone and its relation to albumen, by Dr. E. Herth.—On the barometrical pressure at Vienna, by Dr. J. Hann.—On a new apparatus for the direct volumetric determination of the moisture of the atmosphere, by Prof. Fr. Schwackhöfer.—On the heat-capacity of mixtures of methylic alcohol and water, by E. Lecher.—On the electric after-currents of transversely magnetised iron rods, by Prof. H. Streintz.—On the velocity of transmission of spark-waves, by E. Mach, O. Tumlirz, and C. Kögler.—On the behaviour of propylglycol at a high temperature, by E. Linnemann.—On the direct transformation of isobutyl iodide into trimethylcarbinolamine, by B. Brauner.—On the artificial malic acid made from fumaric acid, by F. Loidl.—On Maxwell-Sympson's synthesis of acroleïne from acetone diiodide, by Dr. O. Voelker.—On the behaviour of β bibromopropionic acid towards iodide of potassium, by V. von Zotta.—Determination of the orbit of comet II 1874, by E. Wenzel.—On Ampère's electrodynamic fundamental experiments, by A. von Ettingshausen.—On bixine, by C. Etti.—On the decomposition products obtained by fusing hydrate of potash with an ammonia gum resin from Marocco, by Dr. G. Goldschmiedt.—On the action of bromine upon phenoldisulphonic acid, by M. von Schmidt.—On the construction of tangents to a rotation plane, by H. Drasch.—On some oxidation products of protocatechic acid, by Dr. M. Gruber.—On trisulfoxybenzoic acid, by Dr. M. Kretschy.—On the variation tone observed by Dvorak, by A. Haberditzl.—On the reduction of ellagic acid by means of zinc dust, by L. Barth and G. Goldschmiedt.—On a fluorescine-carbonic acid, by Dr. J. Schreder.—On the galvanic polarisation of platinum in water, by Franz Exner.—On trinitro- and trinitrophloroglucine, by Dr. R. Benedikt.—On the determination of the focus of the outlines of planes of the second degree, by C. Pelz.—On a synthesis

of pimelinic acid, by A. Bauer and J. Schuler.—New experiments to test Doppler's theory on the change of tone and colour by motion, by E. Mach.—On the magnetic declination and inclination at Vienna, by J. Liznar.—On the component parts of coralline and their relation to the colouring-matters of the rosaniline group, by C. Zulkowsky.—On the diffusion of carbonic acid by water and alcohol, by J. Stefan.—On the electromotive power of metals in the watery solutions of their sulphates, nitrates, and chlorides, by Dr. F. Streintz.

THE *Sitzungsberichte* of the Vienna Academy of Sciences (Physiological and Anatomical Section, vol. 76, parts 1–5) contain the following papers:—Observations on the origin of the cell nodule, by S. Stricker.—On the nerves of the cornea and its vessels, by Dr. L. Königstein.—On the properties of dialysed albumen, by Dr. M. Laptschinsky.—On the occurrence of two different knots of vessels in the kidney, by Dr. O. Drasch.—On some peculiar products of mycotic keratitis giving the amyloid reaction, by Dr. A. Frisch.—On the chemical reaction of the retina and the visual nerve, by Dr. A. Chodin.—On the laws of nerve irritation, by Dr. E. v. Fleischl.—On the termination of the olfactory nerves, by S. Exner.—On optional and cramp movements, by E. Brücke.—Researches on the perception of locality and its relation to the idea of space, by S. Stricker.—On the anatomy of the thalamus opticus and its surroundings, by Dr. F. Schnopfhagen.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 6.—"Preliminary Report upon the *Comatulæ* of the *Challenger* Expedition." By P. Herbert Carpenter, M.A., Assistant Master at Eton College. Communicated by Sir Wyville Thomson, F.R.S. Published by permission of the Lords Commissioners of the Treasury.

The collection of *Comatulæ* made by the staff of the *Challenger* includes specimens from 45 different localities, but few of which are deep-water stations. *Comatulæ* were only obtained seven times from depths exceeding 1,000 fathoms.

At lesser depths, 200—1,000 fathoms, *Comatulæ* were met with at 13 stations; but by far the greatest number both of species and of individuals were dredged at depths much less than 200 fathoms, and often less than 20 fathoms, at 26 widely distant stations.

The collection contains 111 species, mostly new; but as the work of examination and description progresses, it is not unlikely that forms now considered different may turn out to be merely local varieties of one and the same species, so that the number given above may be subject to alteration.

Of these 111 species, 59 belong to the genus *Antedon*, 48 to *Actinometra*, 1 to *Ophiocrinus*, and 3, which are peculiar in having ten rays to the calyx instead of only five, to a new genus for which is proposed the name *Promachocrinus* (πρόμαχος *Challenger*).

The distribution of *Promachocrinus* is as follows:—

P. Kerguelensis (20 arms).	Balfour Bay, Kerguelen,	20—60	fath.
	Royal Sound ,,	28	fath.
	Cape Maclear ,,	30	,,
	Heard Island	75	,,
P. abyssorum (10 arms).	Station 147	1,600	,,
	,, 158	1,800	,,
P. Naresii (10 arms).	,, 214	500	,,

Ophiocrinus was obtained at four localities at depths varying from 565 to 1,070 fathoms, two in the South Pacific off South Australia and New Zealand respectively, and two in the North Pacific, one off Japan, and one just north of the Philippine Islands. All the specimens belong to one species, which is by no means so slender and graceful as Semper's Philippine species from shallower water, but has a much more massive arm skeleton.

The comparative distribution of the other *Comatulæ* is very striking. Relatively speaking, *Actinometra* is extremely limited in its range, both geographical and bathymetrical. It is almost exclusively a tropical genus, its northern limit being about 30° N. lat. and its southern 40° S. lat. Isolated species are known from the Cape of Good Hope, Natal, South Australia, and Port Jackson, but its chief home is Oceania, especially the Philippines and Moluccas. A few *Actinometra* species are also known from the west coast of the Atlantic, as South Carolina, the West Indies, Bahia, and St. Paul's Rocks.

The bathymetrical limit of *Actinometra* is likewise very slight. Nearly all the *Challenger* species are from depths less than 20 fathoms, while only three come from a greater depth than 100 fathoms. The individual species of *Actinometra*, like the genus itself, are very local in their distribution. Each of the forty-eight species of the *Challenger* collection has its own locality.

With *Antedon*, however, the case is different. Not only do nearly all the deep-sea *Comatulæ* belong to this genus, but some species of it have a fairly wide range. *Ant. rosacea* ranges from the north of Scotland to the Mediterranean, while *Ant. Eschrichtii* is found over a much wider area. It is well known on the American coast, and was dredged by the *Challenger* off Halifax, while the *Porcupine* met with it in the "cold area" of the North Atlantic.

Some *Antedon* species occur in duplicate from different localities. Two species from near the Kermadec Islands (S. 170), also occur in the neighbourhood of the Fijis (S. 174, 175). A third species was dredged at Stations 147 and 160, two localities in the Southern Sea, in nearly the same latitude, but separated by almost 90° of longitude. A fourth species came up from 1,070 and 775 fathoms, off the Admiralty Islands and Japan respectively.

The above facts would seem to show that, with few exceptions, the geographical range of the individual members of the family *Comatulidæ*, is exceedingly limited, nearly every species having its own locality, and that not a very extensive one.

The voyage of the *Challenger* has settled a curious question in connection with the Crinoids, the origin of which is due to Lovèn. It refers to *Hyponome Sarsii*, a so-called recent Cystid, which turns out to be nothing more than the disk of a *Comatula*, minus its skeleton. The anambulacral plating may be very extensive, forming a complete pavement over the ventral surface of the disc as in many *Pentacrini;* and the ambulacra are not wide and open as is usual in most *Comatulæ*, but almost entirely closed by the approximation of the marginal leaflets at their sides, so that the food-grooves radiating from the mouth are converted into tunnels.

The plates in the marginal leaflets are probably movable as unplated leaflets are in *Antedon rosacea*; so that they can be erected when the arms are spread out, leaving the grooves open for food particles to travel towards the mouth. On the other hand, when the arms are all contracted over the disk, the marginal plates fold over the grooves and cover them in. This is the condition of most spirit-specimens, but it is not in any way comparable to that of the palæozoic crinoids, in which the mouth is truly subtegminal while the ambulacra become real tunnels beneath the upper surface of the vault.

Sections through one of these plated *Hyponome*-disks show that all the various structures which underlie the grooves of ordinary *Comatulæ* are present and exhibit their usual characters.

The examination of the *Challenger Comatulæ* has entirely confirmed the opinions held by Dr. Lütken and the author respecting the distinguishing characters of *Antedon* and *Actinometra*. Both agree in referring forms with a (sub) central mouth, five equal ambulacra, and no terminal comb on the oral pinnules, to *Antedon*. On the other hand, species with an eccentric mouth, a variable number of unequal ambulacra, and a terminal comb to the oral pinnules, belong to *Actinometra*.

It will be seen at once that these characters are of no use in distinguishing the genera of fossil *Comatulæ*. But, there are very considerable differences in the shape of the radials and centrodorsal piece in *Antedon* and *Actinometra* respectively, and as these are exactly the parts which are most met with as fossils, the generic determination of a fossil form is almost as easy as that of a recent one, which has given up its disk to produce a *Hyponome*. The author has shown elsewhere that in *Act. polymorpha* and *Act. solaris*, half, or even more than half, of the arms may have neither ventral groove, tentacles, ambulacral epithelium, nor ambulacral nerve. No less than 23 out of the 48 species of *Challenger Actinometræ* may have more or fewer of such ungrooved arms, in which the ambulacral nerve is entirely absent. These arms are usually those which come off from the hinder part of the disc, but in one gigantic Philippine species with over 100 arms, there are several ungrooved arms on each radius. Evidence of this negative character appears to the author to be a serious objection to the German view, that the ventral bands constitute the sole nervous apparatus of the crinoids; and on the other hand, to strengthen the opinions held by Dr. Carpenter, and by the author, that the axial cords of the skeleton are also nervous in character.

"Observations on the Physiology of the Nervous System of the Crayfish (*Astacus fluviatilis*)," by James Ward, M.A., Fellow of Trinity College, Cambridge. Presented by Michael Foster, M.D., F.R.S., Prælector of Trinity College, Cambridge.

The experiments, of which this paper gave a brief account, consisted mainly in severing (1) one or (2) both of the supra-œsophageal commissures, (3) both the sub-œsophageal commissures, or (4) in dividing the supra-œsophageal ganglia longitudinally. From these experiments it was inferred :—

(*a*) That there is no decussation of the longitudinal fibres in the nervous system of the crayfish.

(*b*) That on the presence of the supra-œsophageal ganglion depend (1) the spontaneous activity of the animal as a whole, or what might be called its volitional activity ; (2) the power to inhibit the aimless and wasteful mechanical activity of the lower centres ; (3) the power to maintain equilibrium ; and (4) the use of the abdomen in swimming.

(*c*) That the sub-œsophageal ganglion is the centre for co-ordinating (1) the locomotive, and (2) the feeding movements, and (3) for a peculiar rhythmic swing of the limbs seen as soon as the supra-œsophageal ganglia are removed, and (4) is the source of a considerable amount of motor energy.

(*d*) That there is much less solidarity, a much less perfect *consensus*, among the nervous centres in the crayfish than in animals higher in the scale. The brainless frog, *e.g.*, is motionless, except when stimulated, and even then does nothing to suggest that its members have a life on their own account ; whereas the limbs of a crayfish deprived of its first two ganglia, are almost incessantly preening, and when feeding movements are started, the chelate legs rob, and play at cross purposes with, each other as well as four distinct individuals could do.

(*e*) That some stimulus from other centres is more or less necessary to the activity of any given centre.

(*f*) The "natural" discharge of a ganglionic centre (not exhibiting "volition") appears to be of a rhythmic kind ; the rhythmic movements becoming converted into varied movements by temporary augmentation or inhibition.

Zoological Society, March 4.—Prof. W. H. Flower, F.R.S., president, in the chair.—Mr. Sclater exhibited and made remarks on examples of two rare Fruit Pigeons, of the genus *Carpophaga*.—Mr. L. M. D'Albertis exhibited some new and rare birds, obtained during his recent expedition up the Fly River, New Guinea.—Prof. Newton exhibited, on behalf of Mr. J. Robinson, of Trinity Hall, Cambridge, a specimen of *Sylvia nisoria*, believed to have been killed at Cambridge many years ago.—A communication was read from Mr. L. Taczanowski containing a list of the birds collected by Messrs. Stolzmann and Jelski, in Northern Peru in 1878. Fifty-six species were enumerated, several of which were new to science.—Mr. R. Bowdler Sharpe, F.Z.S., read some notes on birds obtained on Kina-Balu Mountain, in North-Western Borneo, by the collectors of Mr. Treacher, amongst which were several species new to science.—Mr. F. Jeffrey Bell read the first portion of some observations on the characters of the Echinoidea. The present paper contained remarks on the species of the genus *Brissus* and on the allied forms *Meoma* and *Metalia*.—A communication was read from the late Mr. F. Smith, F.Z.S., containing the descriptions of new species of *Hymenoptera* from Central America.—A communication was read from Mr. W. A. Forbes, F.Z.S., containing a synopsis of the Meliphagine genus *Myzomela*, to which was also added the descriptions of two new species.—A communication was read from the Rev. O. P. Cambridge, containing descriptions of some new and little known species of Araneidea, principally belonging to the genus *Gasteracantha*.

Chemical Society, March 6.—Dr. Gladstone, president, in the chair.—The following papers were read :—On the quantitative blowpipe assay of mercury, by G. Attwood. The method consists in distilling the compounds either alone or mixed with litharge or with oxalate of potash and cyanide of potassium in ingeniously contrived retorts of glass or steel, the whole apparatus being three to four inches long, collecting the mercury in water, and weighing it when dry.—On some points in the analysis of combustible gases and in the construction of apparatus, by J. W. Thomas. The author has succeeded in exploding marsh-gas, &c., with almost theoretical quantities of oxygen, by using a diminished tension, about 160 mm. As less oxygen is thus required, the author has shortened the eudiometer tube to 500 mm. and thereby increased the delicacy of the apparatus ; he has also reintroduced a steel tap, of, however, perfect tightness, and has in several points perfected and simplified the ordinary Frankland's and McLeod's apparatus. The steel face plates connecting the laboratory and measuring-tubes have also been abandoned.—On the action of isomorphous salts in exciting the crystallisation of super-saturated solutions of each other, and some experiments on super-saturated solutions of mixed salts, by J. M. Thomson. The author finds that a crystal to act as a nucleus must be not only isomorphous, but chemically similar, as to the water of crystallisation and to the substance in solution. Interesting results were obtained by introducing a nucleus into a super-saturated solution of two non-isomorphous bodies ; under certain conditions a separation of these two bodies could be effected.—On the isomeric dinaphthyls, by Watson Smith. The author has determined the vapour densities of the dinaphthyls by means of V. Meyer's new apparatus, and gives in his paper the results of the reaction of carbon tetrachloride, chloroform, &c., on naphthalene.

Geological Society, February 21.—Henry Clifton Sorby, F.R.S., president, in the chair.—George Bond, Francis Gaskell, and George Henry Hollingworth, were elected Fellows of the Society.—The following communications were read :—A copy of a letter from the late Acting-Governor of the Falkland Islands, relating to the overflow of a peat-bog near Port Stanley, in East Falkland. Communicated by H.M. Secretary of State for the Colonies.—Note on *Poikilopleuron bucklandi*, of Eudes Deslongchamps (*père*), identifying it with *Megalosaurus bucklandi*, by J. W. Hulke, F.R.S.—Note on a femur and a humerus of a small mammal from the Stonesfield slate, by H. G. Seeley, F.L.S., F.G.S., Professor of Geography in King's College, London.—A review of the British carboniferous Fenistellidæ, by G. W. Shrubsole, F.G.S.

Anthropological Institute, February 25.—Mr. John Evans, D.C.L., F.R.S., vice-president, in the chair.—A paper by Mr. C. Staniland Wake, on the primitive human family, was read by the Director. The author endeavoured to combat some of the views usually associated with the name of Mr. McLennan.—Mr. E. W. Brabrook, F.S.A., read a paper entitled "Notes on the Colour of the Skin, Hair, and Eyes." The paper accompanied an exhibition of the "Echelle de Couleurs," published by the Société Sténochromique of Paris. The accurate determination of the colours of the skin, hair, and eyes, is a matter of great interest to anthropologists, and the author considered that though the object of the publication of this scale of colours was not exclusively anthropological, yet its value to anthropologists would be very great. Forty-two colours are specialised, of each of which there are about twenty shades.

Victoria (Philosophical) Institute, February 3.—Prof. McK. Hughes, F.R.S., delivered a lecture upon the antiquity of man, in which he analysed the nature of the evidence brought forward by others.

CAMBRIDGE

Philosophical Society, February 24.—Prof. Liveing, president, in the chair.—Prof. Cayley gave an account of an investigation which he had been led to, relating to what he calls the "Newton-Fourier Imaginary Problem." The Newtonian process of approximation to the root of a numerical equation $f(u) = 0$, consists in deriving from an assumed approximate root ξ, a new value $\xi_1 = \xi - \frac{f(\xi)}{f'(\xi)}$ which should be a closer approximation to the root sought for ; taking the coefficients of $f(u)$ to be real, and also the root sought for, and the assumed value ξ, to be each of them real, Fourier investigated the conditions under which ξ_1 is in fact a closer approximation. But the question may be looked at in a more general manner ; ξ may be any real or imaginary value, and we have to inquire in what cases the series of derived values $\xi_1 = \xi - \frac{f(\xi)}{f'(\xi)}$, $\xi_2 = \xi_1 - \frac{f(\xi_1)}{f'(\xi_1)}$, . . . converge to a root, real or imaginary, of the equation $f(u) = 0$. Representing as usual the imaginary value $\xi = x + iy$, by means of the point whose co-ordinates are x, y, and in like manner $\xi_1 = x_1 + iy_1$, &c. ; then we have a problem relating to an infinite plane ; the roots of the equation are represented by points $A, B, C, \ldots$; the value ξ is represented by an arbitrary point P ; and from this by a determinate geometrical construction we obtain the point P_1, and thence in like manner the points P_2, P_3 . . . which represent the values ξ_1, ξ_2, ξ_3 . . . respectively. And the problem is to divide the plane into regions, such that starting with a point P_1 anywhere

in one region, we arrive ultimately at the root *A*; anywhere in another region we arrive ultimately at the root *B*; and so on for the several roots of the equation. The division into regions is made without difficulty in the case of a quadric equation, but in the next succeeding case, that of a cubic equation, it is anything but obvious what the division is, and the author had not succeeded in finding it.

MANCHESTER

Literary and Philosophical Society, February 4.—E. W. Binney, vice-president, F.R.S., in the chair.—The area of the middle drifts as determined by their contents, by Alfred Bell, F.G.S. Communicated by R. D. Darbishire, F.G.S.

February 18.—J. P. Joule, F.R.S., &c., president, in the chair.—On a chemical investigation of Japanese lacquer, or "urushi," by Sadamu Ishimatsu. Communicated by Prof. Roscoe, LL.D., F.R.S.—On the bursting of the gun on board the *Thunderer*, by Prof. Osborne Reynolds, F.R.S., Professor of Engineering, Owens College, Manchester.

BOSTON, U.S.

Society of Natural History, October 2, 1878.—Notes on the physical geography and geology of Trinidad, by W. O. Crosby.

October 16.—The peculiarities in the growth of the Swamp Cypress (*Taxodium distichum*).

October 23.—Museum pests observed in the entomological collection at Cambridge, by Dr. H. A. Hagen.

November 6.—A century of orthoptera. Decade viii. Acridii (Melanoplus), by S. H. Scudder. Decade ix. Acridii (Pezotettix).

VIENNA

Imperial Academy of Sciences, January 23.—The following, among other papers, were read:—Measurements on simultaneous oscillation, by Prof. von Ettingshausen. This relates to a suspended and swinging coil of wire, the currents of which set a galvanometer needle swinging.—On curves of the fourth order with three double points, by Herr Ameseder.—On the diffusion of liquids (second part), by Herr Stephan.

February 6.—On some new and rare fish-species in the zoological museums of Vienna, Stuttgart, and Warsaw, by Dr. Steindachner.—On the occurrence of chlorophyll in the epidermis of leaves of phanerogams, by Herr Stöhr.—On the phenomena in the circulation after temporary closure of the aorta; contribution to the physiology of the spinal chord, by Prof. Mayer.—On the transformation of iodide of phenol into dioxybenzol, by Prof. Lippmann and Herr v. Schmidt.—Variations in structure and growth of the mesentery of the human intestine, by Prof. Toldt.—On organic ferricyanide compounds, by Herr Bernheimer.—Action of the fusing hydrate of soda on phenol, and synthesis of phloroglucin, by Herren Barth and Schreder.

February 13.—On muscular sounds of the eye, by Prof. Hering.—Covellin as a superficial pseudomorphism of a Celtic axe of bronze found at Salzburg, near Hallstatt, by Dr. v. Hochstetter.—Oxidation of resorcin to phloroglucin, by Professors Barth and Schreder.—Remarks on Dr. Wangen's memoir on the geographical distribution of fossil organisms in India, by Herr Wynne.

PARIS

Academy of Sciences, March 3.—M. Daubrée in the chair.—The following papers were read:—Reply to M. van Tieghem concerning the origin of *Amylobacter*, by M. Trécul.—Researches on the fœtal envelopes of the armadillo with nine bands, by M. Milne-Edwards. Exceptionally to the rule with mammalia, the four fœtuses of this armadillo are all lodged in a common chorion.—The waters of the Cheliff; some observations regarding the interior sea of Algeria, by M. Balland. The Cheliff is the principal water-course of Algeria, and flows to the Mediterranean. At present it carries down over three million tons of earthy matters (chiefly silica and clay) in twenty-four hours; this would give a layer 1 metre thick, over 300 hectares. The numerous Saharan rivers lost in the Chotts also convey large quantities of earth and sand; then there is the sand displaced by winds. These considerations are urged against the interior sea.—Discovery of a small planet at the Observatory of Marseilles, by M. Stephan.—Extract from a letter from P. Ferrari, relating to the intra-Mercurial planet. This calls attention to an important observation by P. De Vico in 1837 (which seems to have escaped Leverrier's notice), on a planet-like body which then passed over the sun's disk.—Formulæ relative to the theory of planetary perturbations, by M. de Gasparis.—On the multiplication of elliptic functions, by M. Halphen.—Resolution of a class of congruences, by M. Pellet.—On the emissive power of coloured flames, by M. Gouy.—On the spectra of absorption of didymium, and of some other substances extracted from samarskite, by M. Soret. The facts indicate the existence, in the didymium from samarskite, of a substance at least different from didymium. The same substance seems to be in less quantity in terbine, and in least in the didymium from cerite.—Action of sulpho-cyanate of ammonium on monochlorised acetone, by MM. Norton and Tcherniak.—On amidised acids derived from butyric and isovaleric acids, by M. Duvillier.—Researches on digestion in cephalopod molluscs, by M. Jousset de Bellesme. The posterior salivary glands of the poulpe facilitate the digestion of albuminoids, laying bare the muscular fibre for action of the chief digestive juice. The upper salivaries are merely connected with mastication and swallowing. The animal has a digestive aptitude only for albuminoid and connective matters; and this is the more remarkable because some of its organs, *e.g.*, the liver, contain a large amount of fatty matters.—Researches on *Peronospora ganglii formis* of lettuce, by MM. Bergeret and Moreau. Water slightly acidulated with nitric acid is a good remedy; it poisons the Peronospora and is a manure for the soil.—Influence of oxygen on alcoholic fermentation by beer yeast, by M. Bechamp. In a first series of experiments pure oxygen was conducted into the fermenting mixture continuously. In a second series the electrodes from a battery of six or eight Bunsen elements were put in the mixture; the gases of fermentation were collected, and the oxygen proved to be mostly absorbed. Oxygen acts as an excitant, stimulating the life of the yeast and the mutations of its matter. In the first period of fermentation (with the current) the absolute quantity of alcohol formed was greatest; it diminished to the end. The acetic acid increased from the beginning. The sugar-water absorbs part of the oxygen. Pure yeast in water under weak electrolytic action, may absorb all the oxygen.—On a method of conservation of infusoria, by M. Certes. He employs a solution (2 per cent.) of osmic acid. The important point is to make the reagent act promptly and with a certain force. One way, suitable for most cases, is to expose infusoria on a glass plate to the vapours of osmic acid for ten to thirty minutes. For very contractile infusoria, a drop of the reagent is deposited on the cover before covering the drop of water which contains them. Excess of liquid is removed with Joseph paper; two opposite sides of the cover glass are luted with paraffin or Canada-balsam; and for coloration a mixture of glycerine, picrocarminate, and water (equal parts) is used.—On the unity of forces in geology (continued), by M. Hermite. He offers objections to the hypothesis of igneous fluidity. The present form of the earth is attributed to the presence of its seas. Volcanic phenomena do not agree with the existence of central fire, or even a sea of lava of small extent.—On the hurricane which traversed Switzerland on February 20, 1879, by M. Forel. He finds in the data strong proof of a gyratory motion of the atmosphere.—Theory of glazed frost; reclamation of priority, by M. Nouel.—On some former examples of glazed frost similar to that of January last, by M. Vogt. He gives an account of one instance of the phenomenon observed at Geneva in 1856.

CONTENTS