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THURSDAY, JUNE 25, 1874

THE NEW PHYSICAL LABORATORY OF THE UNIVERSITY OF CAMBRIDGE

ON the 16th inst., at a congregation held in the Senate House, Cambridge, the Cavendish Laboratory was formally presented to the University by the Chancellor. The genius for research possessed by Prof. Clerk Maxwell and the fact that it is open to all students of the University of Cambridge for researches will, if we mistake not, make this before long a building very noteworthy in English science. We therefore put before our readers, as prominently as we can, a description of it.

The Cavendish Laboratory has been erected entirely at the expense of his Grace William Cavendish, Duke of Devonshire, K.G., Chancellor of the University, who has also signified his intention of supplying it with the apparatus necessary for a complete physical laboratory. The building consists principally of three floors, of which the accompanying figures show the plan on a scale of 32 ft. to the inch; Fig. 1 representing the ground-floor, and Figs. 2 and 3 the first and second floors respectively. The west front consists entirely of Ancaster stone; with the exception of the lecture-room and the staircase, which will presently be described, the only ornate portion of the building is the great gateway, X Fig. 1, situated near the south end of this front. The doors, which are very massive, are beautifully carved in oak, and bear, in old English letters, the inscription "Magna opera Domini exquisita in omnes voluntates ejus," which is the Vulgate version of Psalm cxi. 2. Over the gateway are the arms of the Duke of Devonshire on the left, and the University arms on the right, the motto of the Cavendish family, "Cavendo tutus," occupying the centre; and the whole is surmounted with a beautifully carved statue of the Duke in his robes as Chancellor of the University, and bearing in his hand the Cavendish laboratory. The lower portion of the building on the right of the entrance is occupied by the resident attendant. The external walls are 2 ft. thick, the foundation being at a depth of 15 ft. below the surface: with the exception of the west front, the tower, and the portion occupied by the lecture-room, they are built of brick, with Ancaster stone dressings. The tower (marked A in the plans), which is about 17 ft. by 14 ft. 6 in. internal measurement, and 59 ft. in height, contains a very handsome stone staircase with carved oak balustrades.

In describing the internal arrangements seriatim, we shall commence with the room at the east end of the ground-floor marked B in Fig. 1. This room is set apart for magnetic and other observations requiring great steadiness. At *a* is a brick pier about 18 in. high, with a stone top about 4 ft. square. This pier is quite distinct from the tiled pavement of the room, the brick-work being commenced at a depth of about 18 in. below the pavement, and this resting on a foundation of concrete about 18 in. thick. On this pedestal is placed the great electro-dynamometer of the British Association, the two large coils of which are each about half a metre in diameter, and each contains 225 turns of No. 20 copper wire. The diameter of each circle of wire has been accurately measured, as has also the distance betweeen the two bobbins, which is about equal to the radius of either. Th resistance of each coil has also been determined, an thus all the electrical constants of this instrument ar known with great accuracy. It is by comparison wit these coils that the electrical constants of all the othe electro-magnetic apparatus in the laboratory will b determined. For example, the magnitude and position o each circle of wire in each coil being known, the coefficien of induction of the first coil on the second can be at onc found. Suppose, then, we wish to find the coefficient o induction of a third circuit upon a fourth whose resistanc is known. Let the same primary current be sent through the first and third circuits, and let resistances be introduced in the second or fourth until the currents in the two latter are equal. Then the electromotive forces in the second and fourth circuits are proportional to the whole resistance in the circuits, and thus the coefficient of induction of the two pairs of circuits are compared.

At *b* and *c* are stone slabs each 4 ft. square, supported on foundations similar to those last described. On the slab at *b* is placed a unifilar magnetometer of the pattern adopted at Kew. In the upper part of the north wall of this room is a small window for the purpose of determining the direction of the meridian by astronomical observations. This direction being once determined, vertical mirrors will be placed opposite each other on the walls, each mirror being supported by three screws and accurately adjusted by means of nuts so as to serve the purpose of collimation marks. Three mirrors will be placed respectively on the north, east, and south walls of the room, but the fourth mirror will be fixed on the west wall of the room marked F in Fig. 1, in such a position as to be visible through the doorways from the mirror on the north wall of room B. The room marked C in Fig. 1 is called the clock room. In it is a stone pier, *d*, on foundations separate from the rest of the building and intended to carry the principal clock. This clock will be in electric communication with the other clocks in the building, and will from time to time be compared with the clock at the Astronomical Observatory. In this room is also erected a massive stone frame, *e*, intended to carry an experimental pendulum. This, like the clock pedestal, is erected on a foundation similar to that which supports the electro-dynamometer.

Each of the rooms B and C is about 30 ft. by 20 ft. The windows in all the rooms throughout the building have wooden shutters fitted to them, by which they can be completely darkened. On the inside of each window is a large stone shelf, and on the outside a similar shelf in the same plane with it, so that an instrument may be erected with some of its feet inside and some outside the window, a small channel being left between the two to allow the escape of rain-water. The room marked E in Fig. 1 has two large windows on the north side, and will be used exclusively for balances. The best balance at present in the laboratory was constructed by Oertling, and when loaded with a kilogramme in each pan will turn to the weight of a milligramme. This balance while capable of carrying a very considerable weight, is sufficiently delicate for most physical purposes.

The room marked F in Fig. 1 is called the heat room; in it will be conducted experiments in calorimetry, and the like. This room at present contains an apparatus devised by Prof. Clerk Maxwell for determining the viscosity of air.* This is done by causing three glass plates to vibrate between four parallel fixed plates in an air-tight receiver, by means of the torsion of a steel wire. A mirror being connected with the plates, the amplitude of vibration is determined by viewing through a telescope the image of a fixed graduated scale formed by the mirror. The room G on the ground-floor is used for unpacking apparatus, &c., which is brought directly into this room from the street. The apparatus is then raised to the floor above by means of a lift at *k*. H Fig. 1 is used for a workshop; it is furnished with a carpenter's bench and tools, two vices, &c. A 5-inch self-acting screw-cutting lathe will shortly be added, and

North

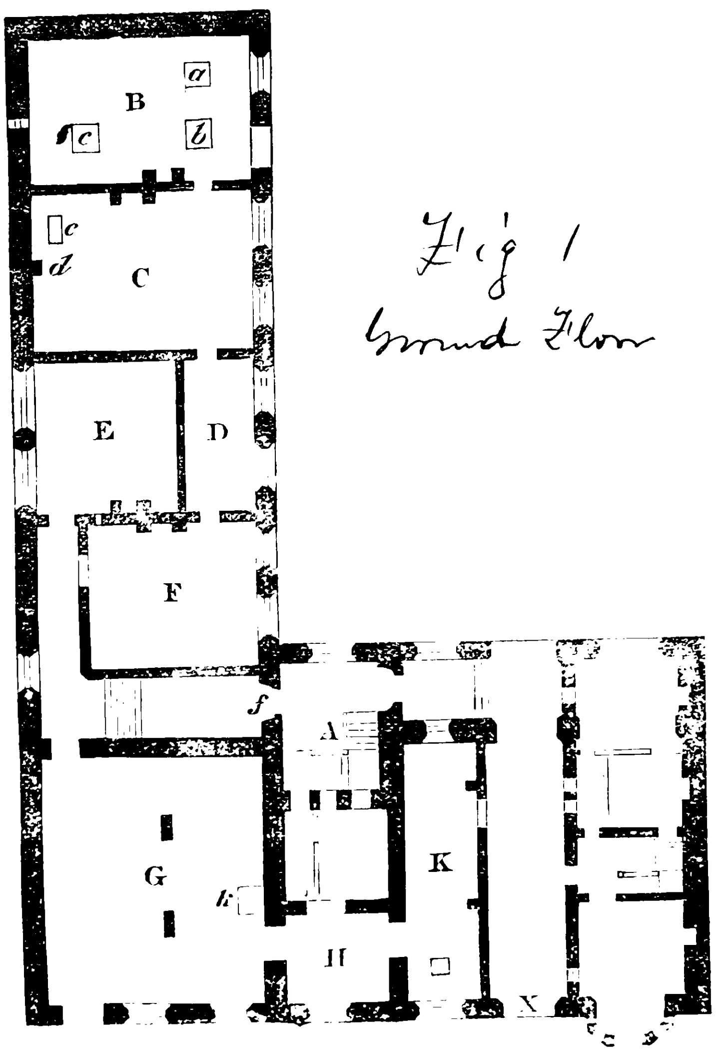

Fig. 1.—Ground Floor.

thus the means will be provided for adjusting and repairing on the premises most of the apparatus required in physical research. The room K is called the battery room; it is situated immediately under the lecture-room, into which wires will be carried from the battery through small hatches in the floor. The battery which will be employed is Sir William Thomson's tray battery, in which the zinc plates will be supported on porcelain cubes of 1-inch edge. The internal resistance of one of these cells is about ·16 ohm. A gas holder containing oxygen gas will also be kept in this room, from which pipes will be carried up into the lecture-room, so that the oxy coal gas lime-light will be always at hand. The south wall of this room, which is 18 in. thick, passes up into the lecture-room independently of the floor, and carries the lecture table. The floor of the lecture-room is supported on two brick piers, which are built about an inch away from this wall. On the stone pavement of the ground-floor a long line will be carefully measured, and with this the other measures of length used in the laboratory will from time to time be compared. At *f* is an old stone gateway of the sixteenth century, which formerly served as the entrance to the Science Schools.

Passing now to the east end of the first floor we find ourselves in the general laboratory (L Fig. 2). This room is 60 ft. long and 30 ft. wide, and is designed to contain twelve large tables, though there are but ten in it at present. Each of the tables in this, as in all the rooms on the first and second floors, is supported independently of the floor on beams resting on brackets fixed in the walls of the

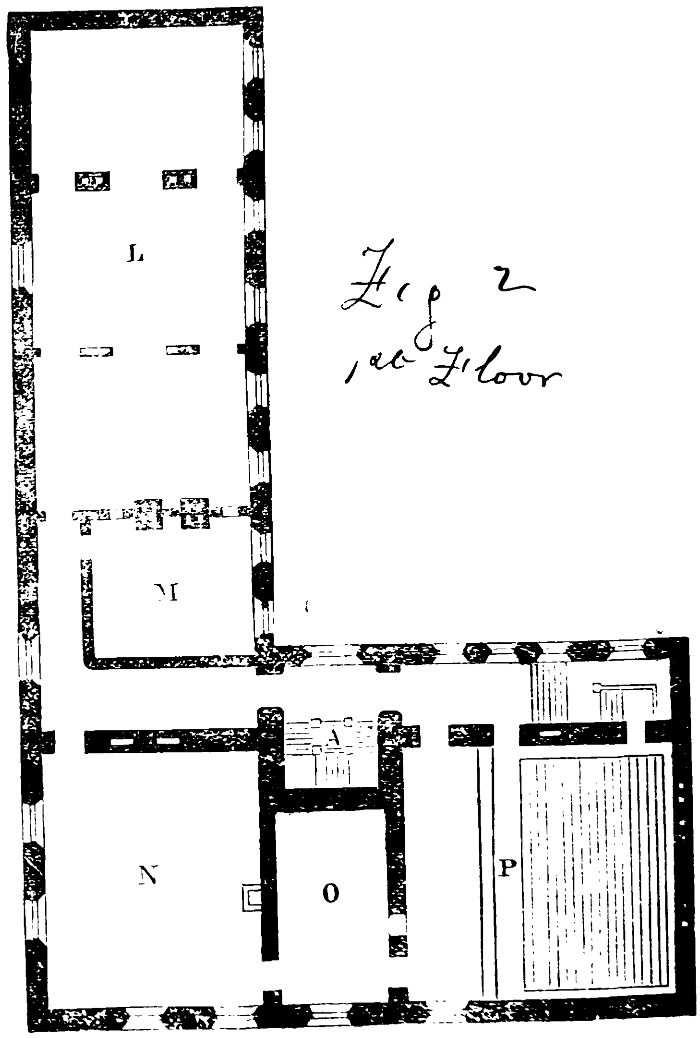

Fig. 2.—First Floor.

rooms below, holes being left in the floor and blocks placed upon the beams so as to be flush with the flooring; it is on these blocks that the legs of the table rest. A stand-pipe, conveying gas, passes up through the centre of each table, and carries connections for four Bunsen or other burners, but can be removed at pleasure. A closet, provided with a good draught into the chimney, will be erected at the east end of this laboratory, in which any experiment producing objectionable fumes, &c., can be conducted. This laboratory is intended for the general use of students. Each room, with one or two exceptions, is provided with an open hearth for a basket fire and a ventilator leading into the chimney near the ceiling. Water is also laid on to all the rooms, which are likewise furnished with leaden sinks; and a plentiful supply of indiarubber tubing lined with canvas will be always on

* See the Bakerian Lecture, Phil. Trans. 1866.

hand in case of fire. The room marked M in Fig. 2 is the Professor's private room. It communicates with the general laboratory by two hatches, which can be opened or closed at pleasure. In the south-west corner of this room is placed Sir William Thomson's quadrant electrometer, made by White of Glasgow. N Fig. 2 is called the apparatus-room. This room will be furnished with glass cases and cabinets, in which will be kept the apparatus which is not in immediate use, and amongst others several classical instruments belonging to the British Association, as for example the original standard unit of electrical resistance and the governor, coil, &c., used in determining this unit. The room O Fig. 2 is called the "preparation-room;" it communicates through a hatch with the lecture-room P. It is intended that the preliminary arrangements

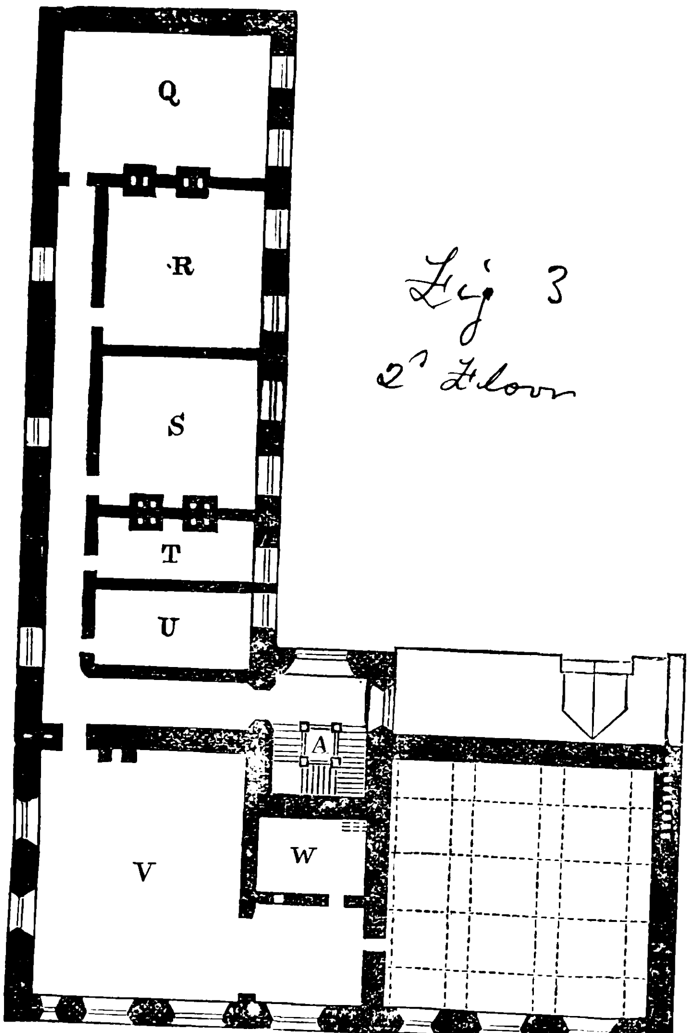

Fig. 3.—Third Floor.

necessary for making experiments during the lectures should be carried out in this room. The lecture-room P is about 38 ft. by 35 ft. and 28 ft. high, and will afford accommodation for about 180 students. The lecture table, which extends throughout the width of the room, is of oak, and is supported on the top of an 18-inch wall as previously described. The seats for the class rise at an angle of about 30°, and there are three doors to provide sufficient means of egress for the audience. The room is panelled to a height of about 9 ft., above which the walls are brick relieved by handsome pillars, which spring from triple conical brackets, and support the ceiling. The room is lighted by three windows at a height of about 17 ft. from the floor, and one window below. Each window is furnished with wooden shutters, which fold together, thus completely darkening the room. The shutters of the three upper windows are opened and closed together by means of endless screws attached to a horizontal shaft which runs under each. The ceiling of the room consists of wooden panels, those near the walls being perforated and forming the bottoms of two horizontal shafts, which lead into a chimney, thus providing an efficient means of ventilation. Three of the panels over the lecture table, as well as the styles between them, can be removed. Above these are two strong tie-beams of the roof, from which Foucault's pendulum or other heavy bodies may be suspended over the lecture table. The panels and styles adjoining the north wall of the lecture-room can also be removed to allow of diagrams being suspended against the wall. On the other three sides of the room the ceiling does not abut directly upon the wall but is coved in the form of a quadrant of a circle, giving the room a very beautiful appearance. This lecture-room is in every respect a model room of its kind. All the rooms on the ground-floor and first floor, with the exception of the lecture-room, are about 15 ft. in height.

On the third floor the room Q Fig. 3 is intended for experiments on acoustics. The room R will be employed for making drawings and calculations; S will be devoted to researches on radiant heat; and T and U are for optical experiments. V is the electrical room. The air in this room will be kept dry by Mr. Latimer Clark's contrivance, which consists of a heated copper roller over which an endless band of flannel passes. The roller is heated by gas-lights within it, and, being kept in constant rotation, every part of the flannel becomes heated in turn by passing over it. The vapour which rises from the heated flannel is carried off by the current of air which supplies the burners inside the roller, and escapes by the flue. The flannel when thus dried and cooled passes into the open air of the room, where it again absorbs moisture from the air, which thus becomes dried, so that the electrical instruments in the room are preserved in a highly insulating condition. From this room a small doorway enters the lecture-room at a height of about 17 ft. from the floor of the latter. An insulated wire connected with the prime conductor of the electric machine will pass through this doorway and thus supply electricity on the lecture table when the air in the lecture-room is too damp to allow of the satisfactory working of the machine. W is a small dark room for photographic and other similar purposes. A small window for a heliostat is placed in the west wall of the electrical room, opposite the door, from which a beam of light may be sent along the whole length of the building so as to allow of diffraction and other experiments, with rays of light 120 ft. in length. All the rooms are heated by hot-water pipes connected with a boiler in the basement. Near the east end of the building copper pipes are employed on each floor for the sake of the magnets in room B.

A lofty flight of steps in the tower leads from the second floor into the roof above the lecture-room, and a few more steps lead into the highest room in the building, which occupies the upper portion of the tower, its floor being more than 50 ft. above the ground. In this room will be placed a Bunsen's water pump, the water from which will thus have a vertical fall of considerably more than 50 ft. This pump will be used to exhaust a large receiver, from which pipes will communicate with the different rooms.

so that if it be desired to exhaust the air from any vessel it will only be necessary to connect it with one of these pipes and *turn on a vacuum*. If a more perfect vacuum be desired than can be obtained by this means, the vessel may be subsequently exhausted by the Sprengel or other air-pump. A metal tube filled with mercury, with glass gauges on every floor for observing the height of the mercury within, will extend throughout the whole height of the tower and will serve as a manometer. The lower end of the tube will pass through the wall and terminate in F Fig. 1. On the top of the tower will be fixed a wooden mast carrying a pointed metal rod, for the purpose of collecting atmospheric electricity. The rod will communicate with the interior of the laboratory by an insulated wire.

The floors of the building are liberally supplied with hatches about 8 in. square, and in most cases those in the first floor are placed vertically under those in the second floor, so that wires may be suspended through the whole height of the building.

The laboratory was designed by Mr. W M. Fawcett, M.A., of Jesus College, and the way in which he has turned to account the space available for his purpose, as well as the simple beauty of his designs have been the subjects of great admiration. Loveday of Kibworth was the contractor.

After the congregation on the 16th the Duke of Devonshire, Sir Bartle Frere, Sir Garnet Wolseley, Prof. Stoletow of Moscow, Prof. Balfour Stewart, Prof. Roscoe, and other distinguished visitors inspected the laboratory and expressed great satisfaction with the building and the arrangements.

Amongst the apparatus at present in the laboratory besides the electro-dynamometer of the British Association, may be mentioned the original B.A. units of resistance, together with the rotatory coil, speed governor, and bridge used in their construction; Sir William Thomson's quadrant electrometer, resistance coils up to 100,000 ohms (a megohm as well as some coils of very small resistance are expected shortly), three mirror galvanometers of different constructions, a 3 ft. 6 in. glass plate electric machine, and a 30 in. ebonite electric machine, Holtz's electric machine, and a hydraulic press, of a peculiar construction, made by Ladd and Co.

THE "CHALLENGER" IN THE SOUTH ATLANTIC

AT the last meeting of the Royal Society a letter from Prof. Wyville Thomson on board H.M.S. *Challenger*, to Admiral Richards, was read, which contained results of such high importance to biological science that were it the only result of the expedition England might have been proud to have had a hand in it. It is most interesting too as carrying on the story of the daily life on board ship which has been touched upon by Prof W Thomson in former communications to NATURE. The letter, which is dated Melbourne, March 17, starts by telling us that south of the line observations in matters bearing upon Prof. Thomson's department were made most successfully at nineteen principal stations, suitably distributed over the track, and including Marion Island, the neighbourhood of the Crozets, Kerguelen Island, and the Heard group.

After leaving the Cape, several dredgings were taken a little to the southward, at depths from 100 to 150 fathoms. Animal life was very abundant ; and the result was remarkable in this respect, that the general character of the fauna was very similar to that of the North Atlantic, many of the species even being identical with those on the coasts of Great Britain and Norway.

Marion Island was visited for a few hours, and a considerable collection of plants, including nine flowering species, was made by Mr. Moseley. A shallow-water dredging near Marion Island gave a large number of species, again representing many of the northern types, but with a mixture of southern forms, such as many of the characteristic southern Bryozoa and the curious genus *Serolis* among Crustaceans. Off Prince Edward's Island the dredge brought up many large and striking specimens of one or two species of Alcyonarian zoophytes, allied to *Mopsea* and *Isis*.

The trawl was put down in 1,375 fathoms on Dec. 29, and in 1,600 fathoms on the 30th, between Prince Edward's Island and the Crozets. The number of species taken in these two hauls was very large, and many of them belonged to especially interesting genera, while many were new to science. There occurred, with others, the well-known genera *Euplectella*, *Hyalonema*, *Umbellularia*, *Flabellum*, two entirely new genera of stalked Crinoids belonging to the Apiocrinidæ, *Pourtalesia*, several Spatangoids new to science, allied to the extinct genus *Ananchytes*, *Salenia*, several remarkable Crustaceans, and a few fish.

The *Challenger* reached Kerguelen Island on Jan. 7, and remained there until Feb. 1. During that time Dr. von Willemoes-Sühm was chiefly occupied in working out the land-fauna, Mr. Moseley collected the plants, Mr. Buchanan made observations on the geology of those parts of the island which were visited, and Mr. Murray and Prof. Thomson carried on the shallow-water dredging in the steam-pinnace. Many observations were made, and large collections were stored.

Two days before the expedition left Kerguelen Island they trawled off the entrance of Christmas harbour, and the trawl-net came up on one occasion nearly filled with large cup-sponges belonging to the genus *Rossella* of Carter, and probably the species dredged by Sir James Clark Ross near the ice-barrier, *Rossella antarctica*.

The *Challenger* reached Corinthian Bay in Yong Island on the evening of the 6th, and all arrangements had been made for examining it, as far as possible, on the following day : but a sudden change of weather obliged Capt. Nares to put to sea. Fortunately Mr. Moseley and Mr. Buchanan accompanied Capt. Nares on shore for an hour or two on the evening of their arrival, and took the opportunity of collecting the plants and minerals within their reach.

The most southerly station was made on Feb. 14, lat. 65° 42′ S., long. 79° 49′ E. The trawl brought up, from a depth of 1,675 fathoms, a considerable number of animals, including Sponges, Alcyonarians, Echinids, Bryozoa, and Crustacea, all much of the usual deep-sea character, although some of the species had not been previously observed.

Prof. Thomson gives a list of the various classes o animals from Sponges to Teleostei, that were met with in nine successful dredgings, at depths beyond 1,000 fathoms, between the Cape and Australia. Many of them, Prof. Thomson states, are new to science, and some are of great interest from their relation to groups supposed to be extinct. This is particularly the case with the Echinodermata, which are here, as in the deep water in the north, a very prominent group.

During the present cruise special attention has been paid to the nature of the bottom, and to any facts which might throw light upon the source of its materials. This department has been chiefly in the hands of Mr. Murray; and Prof. Thomson gives the following extracts from Mr. Murray's notes:—

"In the soundings about the Angulhas bank, in 100 to 150 fathoms, the bottom was of a greenish colour, and contained many crystalline particles (some dark-coloured and some clear) of Foraminifera, species of *Orbulina*, *Globigerina*, and *Pulvinulina*; a pretty species of *Uvigerina*, *Planorbulina*, *Miliolina*, *Bulimina*, and *Nummulina*. There were very few Diatoms.

"In the deep soundings and dredgings before reaching the Crozets, in 1,900, 1,570, and 1,375 fathoms, the bottom was composed entirely of *Orbulina*, *Globigerina*, and *Pulvinulina*, the same species which we get on the surface, but all of a white colour and dead. Of Foraminifera, which we have not got on the surface, I noticed one *Rotalia* and one *Polystomella*, both dead. Some Coccoliths and Rhabdoliths were also found in the samples from these soundings. On the whole, these bottoms were, I think, the purest carbonate of lime we have ever obtained. When the soundings were placed in a bottle, and shaken up with water, the whole looked like a quantity of sago. The *Pulvinulinæ* were smaller than in the dredgings in the Atlantic. We had no soundings between the Crozets and Kerguelen.

"The specimens of the bottom about Kerguelen were all from depths from 120 to 20 fathoms, and consisted usually of dark mud, with an offensive sulphurous smell. Those obtained farthest from land were made up almost entirely of matted sponge-spicules. In these soundings one species of *Rotalina* and one other Foraminifera occurred.

"At 150 fathoms, between Kerguelen and Heard Island, the bottom was composed of basaltic pebbles. The bottom at Heard Island was much the same as at Kerguelen. The sample obtained from a depth of 1,260 fathoms, south of Heard Island, was quite different from anything we had previously obtained. It was one mass of Diatoms, of many species, and mixed with these a few small Globigerinæ and Radiolarians, and a very few crystalline particles.

"The soundings and dredgings while we were among the ice in 1,675, 1,800, 1,300, and 1,975, gave another totally distinct deposit of yellowish clay, with pebbles and small stones, and a considerable admixture of Diatoms, Radiolarians, and Globigerinæ. The clay and pebbles were evidently a sediment from the melting icebergs, and the Diatoms, Radiolarians, and Foraminifera were from the surface-waters.

"The bottom, from 1,950 fathoms, on our way to Australia from the Antarctic, was again exactly similar to that obtained in the 1,260 fathoms sounding south of Heard Island. The bottom at 1,800 fathoms, a little farther to the north (lat. 50° 1′ S., long. 123° 4′ E.), was again pure 'Globigerina-ooze,' composed of *Orbulinæ*, *Globigerinæ*, and *Pulvinulinæ*.

"The bottom at 2,150 fathoms (lat. 47° 25′ S., long. 130° 32′ E.) was similar to the last, with a reddish tinge, and that at 2,600 fathoms (lat. 42° 42′ S., long. 134° 10′ E.) was reddish clay, the same which we got at like depths in the Atlantic, and contained manganese nodules and much decomposed Foraminifera."

Mr. Murray, Prof. Thomson goes on to say, "has been induced by the observations which have been made in the Atlantic, to combine the use of the towing-net at various depths from the surface to 150 fathoms, with the examination of the samples from the soundings. And this double work has led him to a conclusion (in which I am now forced entirely to concur, although it is certainly contrary to my former opinion) that the bulk of the material of the bottom in deep water is in all cases derived from the surface.

"Mr. Murray has demonstrated the presence of Globigerinæ, Pulvinulinæ, and Orbulinæ throughout all the upper layers of the sea over the whole of the area where the bottom consists of 'Globigerina-ooze' or of the red clay produced by the decomposition of the shells of Foraminifera; and their appearance when living on the surface is so totally different from that of the shells at the bottom, that it is impossible to doubt that the latter, even although they frequently contain organic matter, are all dead. I mean this to refer only to the genera mentioned above, which particularly form the ooze. Many other Foraminifera undoubtedly live in comparatively small numbers, along with animals of higher groups, on the bottom."

It is very curious to note that in the extreme south the conditions were so severe as greatly to interfere with all work. "We had," Prof. Thomson says, "no arrangement for heating the work-rooms, and at a temperature which averaged for some days 25° F the instruments became so cold that it was unpleasant to handle them, and the vapour of the breath condensed and froze at once upon glass and brass work. Dredging at the considerable depths which we found near the Antarctic circle became a severe and somewhat critical operation, the gear being stiffened and otherwise affected by the cold, and we could not repeat it often.

"The evening of Feb. 23 was remarkably fine and calm, and it was arranged to dredge on the following morning. The weather changed somewhat during the night, and the wind rose. Captain Nares was, however, most anxious to carry out our object, and the dredge was put over at 5 A.M. We were surrounded by icebergs, the wind continued to rise, and a thick snow-storm came on from the south-east. After a time of some anxiety the dredge was got in all right; but, to our great disappointment, it was empty probably the drift of the ship and the motion had prevented its reaching the bottom. In the meantime the wind had risen to a whole gale, force = 10 in the squalls, the thermometer fell to 21°·5 F., the snow drove in a dry blinding cloud of exquisite star-like crystals, which burnt the skin as if they had been red hot, and we were not sorry to be able to retire from the dredging-bridge.

"The specific gravity of the water has been taken daily by Mr. Buchanan; and during the trip Mr. Buchanan has determined the amount of carbonic acid in 25 different samples 15 from the surface, 7 from the bottom, and 2 from intermediate depths. The smallest amount of carbonic acid was found in surface-water on Jan. 27, near Kerguelen; it amounted to 0·0373 gramme per litre. The largest amount, 0·0829 gramme per litre, was found in bottom-water on Feb. 14, when close to the Antarctic ice. About the same latitude the amount of carbonic acid in surface-water rose to the unusual amount of 0·0656 gramme per litre; in all other latitudes it ranged between 0·044 and 0·054 gramme per litre. From the greater number of these samples the oxygen and nitrogen were extracted, and sealed up in tubes.

"While we were among the ice all possible observations were made on the structure and composition of icebergs. We only regretted greatly that we had no opportunity of watching their birth, or of observing the continuous ice-barrier from which most of them have the appearance of having been detached. The berg- and floe-ice was examined with the microscope, and found to contain the usual Diatoms. Careful drawings of the different forms of icebergs, of the positions which they assume in melting, and of their intimate structure, were made by Mr. Wild, and instantaneous photographs of several were taken from the ship.

"I need only further add that, so far as I am able to judge, the expedition is fulfilling the object for which it was sent out. The naval and the civilian staff seem actuated by one wish to do the utmost in their power, and certainly a large amount of material is being accumulated.

"The experiences of the last three months have, of course, been somewhat trying to those of us who were not accustomed to a sea-life; but the health of the whole party has been excellent. There has been so much to do that there has been little time for weariness; and the arrangements continue to work in a pleasant and satisfactory way."

COLONIAL GEOLOGICAL SURVEYS

I.—CANADA

Report of Geological Survey of Canada for 1872-73.

RATHER less than thirty years ago the Canadian Legislature passed a vote for the institution of a Geological Survey of the province, with the object of ascertaining definitely the mineral resources of the country. In pursuance of this decision, the Governor-General, after some inquiry about a properly qualified individual to take charge of the Survey, finally appointed Mr. W. E. Logan, who, born in Canada, had made his name known in England by some careful surveys of the South Welsh Coalfield, and by original observations on the origin of coal. For thirty long years of unremitting labour, with obstacles of every kind, physical, pecuniary political, the brave and sagacious director stuck to his post. Many a time with a legislature impatient for practical results in the discovery of minerals, and a ministry indifferent to science and bent on popularity by retrenchment of the budget, the chances of the Canadian Survey seemed desperate. But the pilot who guided its destinies showed himself as shrewd a judge of men, and as able to win them over, as he was a skilful pioneer in geology. And the result is that he has made the Canadian Geological Survey one of the first in the world, excellent in its equipment, considering the slender means placed at his disposal, and altogether admirable for the vast amount of solid work which it has accomplished—work which has not merely been of service to Canada, but has acquired a world-wide interest. In doing this he has made his own name a household word among geologists of every country. Canada may well be proud of her Sir William Logan.

About four years ago, having toiled so long and hard, he felt compelled to relinquish his post and seek the rest which his old age so needed and deserved. He was succeeded by Mr. Alfred R. Selwyn, who had been trained in the early days of the Geological Survey under Sir Henry De la Beche, had done much excellent and difficult geological work in Wales, and had thereafter held for a number of years the post of Director of the Geological Survey of Victoria. The Victorian authorities in 1869 suppressed their survey. When Mr. Selwyn lost that appointment, he was induced to accept the guidance of the establishment in Canada. There could hardly have been found a fitter successor to Sir William Logan. Long experience in all the details of geological surveying, both in civilised and in still unexplored regions, must have made it an easy matter for Mr. Selwyn to adapt himself to Canadian modes of exploration. He was renowned in his old Welsh days for his prowess as a mountaineer, and to judge from the present report the advance of years has not perceptibly impaired his bodily activity and powers of endurance. During the comparatively brief season when geological reconnaissances are possible in British North America he is found at one time away in the far east of the dominion inspecting mines in Nova Scotia, at another time with his colleagues and Indians laboriously toiling through river, lake, and portage, in the still only partially explored regions towards Fort Garry, or camping out for many weeks on the shores of Lake Superior. During 1872 the operations of the Canadian Survey under his charge extended across the whole breadth of North America at its broadest part, that is from the Queen Charlotte Islands to the headlands of Nova Scotia—a distance, in a straight line, of considerably more than 3,000 miles.

The success of such a service as that of the Canadian Geological Survey must depend, however, in large part on the calibre of the men who act under the director. And Mr. Selwyn is fortunate in his staff, which is nearly the same as that under Sir William Logan. Of his explorers in the field Mr. R. Bell and Mr. James Richardson have done much of that sound work on which the reputation of the Canadian Survey rests. To Mr. Billings, who determines his fossils, and to Dr. Dawson, who, though not attached to the Survey, generously lends his assistance in the palæontological department, the Survey is likewise largely indebted. As an analyst of minerals and ores and an able writer on chemical geology Sir William Logan had a tower of strength in Dr. Sterry Hunt, who has lately accepted an appointment in the United States. Dr. Hunt's successor, Dr. Harrington, carries with him into his new duties the good wishes of all geologists who take interest in the pursuit of mineralogy and petrography and in the perplexing problems of metamorphism. One of the oldest and best of Sir William's staff, Mr. Murray, has now an independent sphere of work in Newfoundland. He has issued a number of reports, to which and to his other services we shall return on a future occasion.

Geological field-work in Canada differs very markedly from field-work in most other countries. Most of the districts over which the Survey is now extending are in great measure, or wholly, unexplored, some of them, indeed, having never been visited by a white man before the adventurous geologist attacked their rocks with his hammer. There being no roads, and the country thickly timbered, the rivers form the natural routes for exploration. Each member of the staff receives in the early summer his instructions as to the area to be surveyed during the five or six months at most when surveying is possible. Providing himself with birch-bark canoes, two or more white men as *voyageurs*, and a variable band of Indians as guides and portage carriers, likewise with provisions for the entire party for the whole season during which the tour is to last, he starts on his voyage of discovery. Of course in such regions he has either no map at all or some mere rough sketch, so that he needs to construct the topography as well as the geology of his charts. Ascending the river which has been chosen, the party halts each night at some favourable creek and sleeps under cloaks or skins upon the shore. Sir William Logan used to sleep in a sack on the beach of Lake Superior, with his head stuck out of the mouth of it, and after tucking himself in would sometimes need to creep out again to knock off the edge of some protuberant rock, and thus literally to smooth his bed with his hammer. Expertness as a shot forms a valuable qualification in one of these explorers, and enables himself and his comrades now and then to enjoy the luxury of fresh meat. Great trouble often arises with the Indian attendants. Sometimes they cannot be had at all, and when obtained are apt to depart at a moment's notice, leaving the white men to manage their journey as they best can.

The Report of the Canadian Survey for 1872-73 bears the stamp of the same thorough unostentatious work which has characterised the whole of the long series of Reports from 1843 downwards. In such a yearly summary of progress we cannot expect the completeness of a finished memoir. The observers merely chronicle what they have seen in the tracts visited by them. But on this account their Reports are probably all the surer an index to their powers of rapid observation and of grasping main features of geological structure. In this aspect Mr. Richardson's Report, On the coalfields of Vancouver and Queen Charlotte Islands, deserves high commendation. By the time he could get himself transported across the continent to San Francisco, and thence by steamer to the part of Vancouver Island where his explorations were to be made, it was the beginning of July, and the heavy rains began before the end of September. In spite of wind and wet, however, he stuck to his work, and after storing away his boat, tent, and camp-equipage for next year's service, set out once more on his long journey, and reached Montreal in the middle of December. During these few and interrupted months he added considerably to what was previously known regarding the secondary coalfields of that part of America, made a number of careful measurements of the thicknesses of the strata, and brought home many fossils, both plant and animal, new to science.

He found that the coal-bearing rocks lie upon a vast depth of older crystalline masses among which he detected fossiliferous limestones. This metamorphosed series he estimates at somewhere about 17,000 ft. in thickness. When the fossils were submitted to Mr. Billings, that able palæontologist found them too obscurely preserved to warrant a definite opinion as to their age. From his reference of some of the corals to such genera as *Zaphrentis*, and the occurrence of *Productus*, *Spirifer*, and *Fenestella*, the rocks would at least seem to be certainly Upper Palæozoic, though he does not go further than to suggest that they may be "either Permian or Carboniferous, more probably the latter." On this great metamorphic group the coal-bearing rocks rest unconformably. To these rocks Mr. Richardson assigns a thickness of 5,000 ft. They consist of various shales, sandstones, shell-bearing limestones, and conglomerates with intercalated seams of coal, very much resembling apparently some parts of our Carboniferous sections in Britain. Their geological position appears to be about the parallel of our Cretaceous and perhaps the upper part of our Jurassic series. Among the plants Dr. Dawson finds some forms of cypress and yew, cycads and ferns, with species of oak, birch, and poplar, and remarks that these fossils furnish additional evidence of a fact already noticed, "that in the Cretaceous period the generic types of American trees were as well marked as at present." Among the shells, Mr. Billings finds 16 species of Ammonites, 2 of Belemnites, a Nautilus, 4 Gasteropods, and 9 genera of Lamellibranchs, the general facies of the whole being decidedly Cretaceous and Upper Jurassic. He admits the view of the States geologists to be substantially correct, that the coal of Vancouver Island belongs to one of the Cretacous groups which is developed in northern California and Oregon. At the same time the fossil evidence suggests that while the Vancouver beds may be Upper Cretaceous, those of the Queen Charlotte Islands are partly Lower Cretaceous and partly Upper Jurassic. From the fact that the fossils in the Cretaceous formations on the west side of the Rocky Mountains are specifically different from those on the east side, Mr. Billings suggests the former existence of a land-barrier down the American continent on which the abundant Cretaceous flora flourished.

The route followed by Mr. Bell, of which an account is given in this Report (On the country between Lake Superior and Lake Winnipeg), presented comparatively little of general interest, though it gave scope for the same methodical and careful work for which his previous reports are distinguished. One fact deserves notice among his remarks, namely, that he has confirmed his previous observations of a great conformable series of metamorphosed Huronian rocks resting upon the Laurentian gneiss. Mr. Selwyn suggests that the conformability may be only local and deceptive. This is certainly a matter deserving attentive examination. Mr. McOuat contributes a well-written Report on the country between Lakes Temiscamang and Abbitibbe, where he was busy tracing the relations of some of the metamorphic rocks there to those on Lakes Huron and Superior. Mr. Vennor's Report deals with a more civilised part of the country, which had already, to some extent, been examined by the Survey. He is evidently an accession of great strength to the staff.

While explorations were in progress on the shores of the Pacific among the Vancouver coalfields, other members of the Survey were busy on the Atlantic borders among the coalfields of New Brunswick and Nova Scotia. Prof. Bailey and Mr. Matthews have written a valuable account of the New Brunswick region, which it is to be hoped will be extended and published with sections and fuller details. Several other Reports are included in the volume, having more of a practical than a scientific interest. In fine, the Geological Survey of Canada may be congratulated upon the evidences of continued activity which this volume furnishes. The form of such Annual Reports necessarily precludes a systematic treatment of the subject, and makes it somewhat difficult for readers unfamiliar with the localities to grasp the main features of geological importance amid the manifold local details. It is earnestly to be wished, therefore, that before many years pass away another general volume may be issued like that which Sir William Logan published eleven years ago.

ARCH. GEIKIE

(To be continued.)

OUR BOOK SHELF

Field Ornithology. By Dr. Elliot Coues. (Naturalists' Agency, Salem.)

OUR ornithological readers are all familiar with Dr. Coues' excellent "Key to North American Birds," which we noticed on its appearance. In that work it was intended that instruction in the best means of collecting and preserving birds should have been incorporated, which was prevented by the unexpected dimensions which the volume assumed. The same author now gives us these important instructions in a separate small manual, with which he combines a check list of the species described in the "Key," arranged in accordance with his own views, as a supplement to the larger work. The subjects treated of will be found of great service to all collectors, especially to those, both amateur and professional, who are commencing to attempt the accumulation and the preservation of bird-skins. The hints on the selection of a gun, shot, &c., will be of especial service to all sportsmen of small game, whilst the carefully-written account of the best way in which the skinning of birds, both large and small, should be undertaken, will well repay the perusal, even of the experienced. The various less well-known means of preserving specimens, as in spirit, and by means of carbolic acid, which latter is not inaptly termed by the author "mummification," are described in detail. Of the carbolic-acid method it is remarked: "I mention the process chiefly to condemn it as an atrocious one; I cannot imagine what circumstances would recommend it, while only an extreme emergency could justify it. It is further objectionable because it appears to lend a dingy hue to some plumages, and to dull most of them perceptibly." Notwithstanding these disadvantages there is one point which recommends this process, it being that the bodies of the birds preserved by it are in a condition quite fit for the dissection of the muscles and other organs, after they have been soaked for some time. Nothing is more difficult than for the students of internal structure to get most of the bodies of which they despondently regard so many skins; and they naturally look with delight at any method which gives them a chance of obtaining the species they desire. The check list will be found of much use to those who collect the birds of North America. It is printed on one side of the page only, and separate copies are to be printed, which can be cut up for cabinet purposes. For those who are commencing ornithology practically we know no book which will prove so serviceable as Dr. Coues' little work.

LETTERS TO THE EDITOR

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

Proposed Issue of Daily Weather Charts of Europe and the North Atlantic

I HAVE the honour to inform you that Capt. Hoffmeyer, Director of the Royal Meteorological Institute of Copenhagen, has sent me a circular announcing his intention to publish daily charts of the weather for the district from 60° E. to 60° W. long. and from 30° to 75° N. lat. The charts for the three months—Dec. 1873-Feb. 1874—will be published as an experiment.

The cost will be four francs per month, exclusive of postal charges.

Capt. Hoffmeyer states that he can only deal with central offices, and has requested me to undertake these islands as regards the distribution of the charts. I have therefore to announce that I have been instructed by the committee to subscribe for twenty-five copies of these charts, and I shall be happy to supply copies for the three months to any gentleman, at the cost of 11*s*. to cover carriage from Copenhagen, and postage from London to his address.

ROBERT H. SCOTT, *Director*

Meteorological Office, June 22

The Degeneracy of Man

DR. OSCAR PESCHEL, in his recently published "Völkerkunde" (p. 137), calls attention to a remark by the late Dr. von Martius, of much interest to anthropologists. It is well known that this distinguished naturalist avowed in the strongest terms his belief that the savage tribes of Brazil were the fallen descendants of more cultured nations. In 1838 he said:—"Every day I spent among the Indians of Brazil increased my conviction that they had once been in quite another state, but that in the lapse of dark ages there had broken in upon them manifold catastrophes, which had brought them down to their actual condition, that of a peculiar decline and degeneration. The Americans are not a wild race, they are a race run wild and degraded." To students of civilisation (myself for example) Dr. Martius' views have been most embarrassing. It was not strange that the theory of savages being the degraded offspring of primeval civilised men should have been advocated by Archbishop Whately, who did not even take the trouble to examine his own evidence. Nor is it surprising that the Bishop of Ely, in the "Speaker's Commentary," should still appeal to Whately as an unrefuted authority, for one hardly expects an orthodox commentator to test the arguments on his own side. But the case with Dr. Martius was quite different. Here was an eminent ethnologist, intimately acquainted with savage thought and life, declaring that it seemed to him not to indicate natural wildness, but to show traces of decay from an ancient higher culture. What made the matter more puzzling, was that Dr. Martius, in his researches, had come upon facts which he acknowledged to be evidence of progress taking place from savage toward civilised institutions. Thus, among the forest tribes of Brazil he found the rudest form of the "village community," with its tribe-land common to all, but the huts and patches of tilled ground treated as acquired private property, not indeed of individuals, but of families. It was manifest that these tribes were passing through stages of that very development of the law of real property which is so clearly shown in the history of European law. This is a strong argument in favour of the development-theory of civilisation, but how could an ethnologist who understood the force of such arguments, remain an upholder of the degeneration-theory?

Dr. Peschel considers that he did not so remain, but had changed his opinion when, nearly thirty years later, he wrote as follows as to the tribes of the vast region of the Amazons. "There are as yet no grounds for considering that the present barbaric condition in these districts is secondary, that any other higher social condition had ever here preceded it, that this swarming-ground of ephemeral unsubstantial hordes had ever been the theatre of a cultured nation."* It is to be noticed, however, that this passage does not seem necessarily to involve a recantation by Dr. Martius of his former opinion. He leaves it quite open that the tribes of the Amazons, though they did not degenerate in this region from civilised ancestors, might have done so elsewhere, and then migrated as savages into the forest regions where as savages they remain. The context may on the whole favour this view of his meaning. Now this matter quite deserves further looking into. It would be well worth while if Dr. Peschel, from personal or published sources available to him, would settle once for all the question whether the great Bavarian ethnologist continued through life the degenerationist that we in England suppose him to have been. Some twenty years ago, Dr. Prichard ("Natural History of Man," 1843, p. 497), citing Martius as to this very matter of the supposed fall of the South American tribes from an original higher state, remarked that "had he taken a more extensive survey of the nations of the whole continent, his opinion might have been somewhat modified." As Dr. Martius did take the more extensive survey thus recommended, it would be particularly curious to ascertain whether it did have the effect thus foretold on his mind.

EDWARD B. TYLOR

* Martius, "Beiträge zur Ethnographie Amerikas," vol. i. p. 375. The other passages here referred to will be found in the same volume, pp. 5, 83.

Flight of Birds

ALLOW me to return thanks to such of your correspondents as have been kind enough to notice the query (vol. viii. p. 86) on this subject which I made through your columns.

As the matter seems to have excited some little interest perhaps you will permit me to state in what respect the solutions proposed appear satisfactory.

That an "upward start" of wind ot sufficient velocity would support a bird of given weight and surface of resistance is no doubt the case. As in still air a bird, by holding its wings in a plane slightly inclined to the horizontal, will glide with a velocity which ultimately becomes uniform, in a straight line obliquely downwards, so the same bird in the same position, but in a current slanting upwards in a like direction and with a like velocity, must remain at rest. Nevertheless there are difficulties in the way of thus explaining the phenomenon.

(1) It supposes the existence of air-currents of greater rapidity and at a greater angle of elevation than are likely often to be met with. Taking the number of square feet in the whole resisting surface of the bird to be equal to the number of pounds in its weight, then a *vertical* current of 15 miles per hour would be required to support a bird with its tail and wings fully unfurled but motionless, and a current of 30 miles per hour would be required if the current ascended at an angle of 30° with the horizon. Now wind directed upwards by encountering the side of a mountain is not likely to be inclined at a greater angle than this, which is the average slope of a very steep mountain side, and moreover the phenomenon of hovering without wing motion may be observed where such rapid currents have no existence.

(2) The phenomenon is sometimes observed where it is almost impossible to suppose the existence of any upward air-currents whatever. The first time it attracted my attention was in the neighbourhood of London, towards Finchley Common, where it will, I think, be admitted that there is nothing in the natural configuration of the ground to determine an upward current of sufficient velocity to produce the required effect. The wind at the time was certainly not boisterous, but as the bird was at a considerable elevation there is still room to imagine that the upper currents in which it was situated might be different from those below. I was informed at the time that the bird in this case was a kite; this may have been an error, as I understand that kites are now rarely seen near London. However this may be I should gladly hear from such of your correspondents as have the opportunity of watching the motions of the kite as to whether the position of motionless hovering, which I believe this bird continually assumes, can be explained always by the existence of upward currents. I do not of course deny but what birds, while hovering, avail themselves of upward currents where they can. If the position is the result of considerable though imperceptible muscular action they would naturally seek to economise their strength as far as possible by availing themselves of whatever support they could get from upward wind currents.

As your correspondent, J. Herschel, implies, it is difficult to dissociate the hovering and the soaring of birds. That birds soar, that is, that they continue suspended in the air for long periods of time together, in rapid motion, with no further apparent movement of the wings than is necessary to guide them, and this under circumstances where it is obviously impossible for them to avail themselves of upward air slants, cannot be denied. Whoever has made the voyage to the Cape must have observed this in the case of the albatross. This bird appears to rise from the sea with great difficulty and with the expenditure of much wing power; but, being once fairly launched in the air, its flight becomes a most inexplicable phenomenon. In the open ocean, during a steady wind, it soars for hours about a ship going at the rate of six or eight knots an hour, without apparent difficulty, and with no further wing motion than seems necessary to guide it, now skimming the water in the wake of the ship, now sweeping round to the side or in front, rising and falling by what has been well described as an apparent act of volition, and with no perceptible loss of velocity. Now I think it must be admitted that the motionless hovering and the soaring of birds are phenomena closely allied to each other, that no explanation of the one is satisfactory which does not explain the other also, and that, as the theory of upward slants cannot possibly explain the soaring of birds, it cannot be accepted as a satisfactory explanation of their hovering.

Besides the "upward air slant" theory, a correspondent of one of your contemporaries refers me to the Duke of Argyll's "Reign of Law" under the supposition that the matter is fully explained in the third chapter of that work. I only refer to this to point out the curious example it furnishes of fallacious reasoning. The author obviously thinks that, by a proper arrangement of its wings and tail and the position of its body, a bird can without muscular exertion remain suspended in a horizontal air-current, *provided the latter be of sufficient velocity* (see p. 170). This of course requires no refutation; but the whole of the chapter in which it occurs may be read with interest as illustrating the curious mistakes a clever and earnest amateur will fall into in writing on even the most elementary scientific subjects in which he has had no exact training.

F. GUTHRIE

Graaff Reinet College, Cape Colony

An Optical Delusion

THE following is an optical delusion which is none the less interesting for being very easily explained.

Let a person standing before a looking-glass look attentively at the reflection of the pupil of one of his eyes, and then at that of the other—let him look at different *parts* of the eye, and from one eye to the other, first at one and then at the other. Knowing that in thus changing the direction of his gaze his eyes *must* move about in their sockets he will expect to see that they do so in the glass. As a fact *they will appear perfectly still.*

If he looks at the eyes of another person trying the experiment, the peculiar fixedness of his own will be still more striking, when he looks at them again.

I will not spoil the riddle by giving the answer at the end.

J. H.

Longevity of the Carp

CAN any of your readers give any well-ascertained proof of the length of life attained by the carp? When residing as a youth at St. Germain, I was told by an aged Legitimist that his father had watched the same carp throughout the whole of his life, and the son asserted that he had known the identical fish for twenty and thirty years after his father's death, thus giving to them an age of from sixty to seventy years. That remarkable statement is more than substantiated by Lady Clementina Davies, who, in "Recollections of Society" (p. 40), alludes to the longevity of the carp in the moat of the Château de St. Germain, one bearing in his gills a ticket proving him to be over 200 year of age; and others at Versailles, bearing silver rings through their gills with the name of the courtier who had inserted it, and testifying to an almost incredible longevity. What amount of truth may we attribute to these statements?

Croydon, Surrey, June 13

ROBT. RODOLPH SUFFIELD

LE GENTIL'S OBSERVATION OF THE TRANSIT OF VENUS

As all the world is now thinking of the transit of Venus, an episode of old time in connection therewith should be very interesting.

In a series of articles by M. W. de Fonvielle in *La Nature*, from which the accompanying illustration is taken, some interesting facts are given concerning Le Gentil's observations of the transit of Venus in the open sea about the middle of last century. These we reproduce here with some supplementary information from Le Gentil's own interesting work referred to below. His voyages extended altogether from 1760 to 1771. They consequently commenced before the transit of 1761, and were continued after that of 1769.

The expeditions of Le Gentil, the account of which, published by the royal press, fills two magnificent volumes, have left an ineffaceable mark upon the history of astronomy. His work is a proof that a man of energy and perseverance who sets himself to the solution of a great and beautiful problem can find, in spite of all obstacles, the means of immortalising himself. Posterity certainly owes some indemnification to the indefatigable astronomer, since his determination to solve scientific questions was undoubtedly prejudicial to his interests, and even to his love-affairs.

A pupil of De l'Isle, Le Gentil was intended for the church by his family, whose home was at Coutances, where he was born Sept. 12, 1725; but his attachment to Mlle. Potier, belonging to one of the richest families of Cotentin, made him give up all idea of so very celestial a profession. A happy marriage, contracted in 1771, after eleven years of absence, enabled him to triumph over his enemies, who had taken advantage of his being far away to fill up his place in the Academy of Science, and against his

Transit of Venus observed on the open sea by Le Gentil in 1761.

relations, who had attempted to take possession of his property; he had to go to law to make them give up what they had taken. His death, which had been announced so often, was very nearly becoming a reality, for he was seized by a dangerous malady, which would have carried him off but for the affectionate care of his wife.

The Duc de la Vrillière, Minister of State, entrusted with the distribution of *lettres de cachet*, was then Director of the Academy. Le Gentil, having received from his bureau the orders of the King, embarked in 1760 for the Isle of France, on board the *Berryer*, a vessel of the Indian Company, which carried fifty guns, and sailed in company of the *Comte-d'Artois* of sixty-four. On July 10 he arrived at the Isle of France. Le Gentil resolved to proceed to Rodriguez, where he did not know that Canon Pingré, who had left Paris after him, had arrived, to execute a mission which he had received from the Academy. The two astronomers would have unexpectedly met on that island, then almost a desert, if Le Gentil had not found at the Isle of France the *Sylphide*, a frigate sent to the help of Pondicherry, Le Gentil's original destination. He, full of ardour, did not hesitate to embark on board of this vessel. But the winds were adverse to the expedition, and the *Sylphide* wandered from March 25, 1761, to May 24, the sport of calms and of the irregular winds of the north-east monsoon. On May 24, when off the coast of Malabar, Le Gentil learned that Pondicherry had been taken by the English. It was then necessary to return to the Isle of France, where the *Sylphide* arrived only on June 23, after having touched at Point de Galle on May 30.

It was between these two stations that Le Gentil observed the transit of Venus, of which the following is his description, stripped of all extraneous details:—

"To observe the entry of Venus I employed an excellent objective of 15 ft. (French) focus, fixed to a tube composed of four pine planks which I had made sufficiently solid without being too heavy. To work it I got a small mast with a halliard fitted on the port quarter-deck. I saw that it was useless to attempt to notice the first moment of the entry of Venus, for I did not want to fatigue myself and run the risk of not being able to observe the total immersion. Indeed, I had sufficient trouble to fix the sun, on account of the movement of the ship.

"When Venus had half entered, or nearly so, on the disk of the sun, which I recognised by my reflecting quadrant, I attached myself, so to speak, to the telescope of 15 ft. to try to catch the moment of total entry. As my watch was none of the best, and as I could not take the height of the sun precisely at the moment when Venus appeared to me to be totally immersed, it occurred to me to make use of the sand-glass, by means of which the way of the vessel was measured, and I had by my side a man well up to turning the glass at the instant in such a way that it was impossible to have an error of more than a quarter of a second each time.

"The weather having become overcast, and the rain having shown itself, I did not think it would be possible to notice the exit of Venus. Consequently I did not cause the mast to be changed, as I ought to have done, for we had tacked since half-past 11.

"At 2 o'clock it cleared a little, and shortly after the weather cleared so that I could see Venus very distinctly with my green objective, and without the help of any other coloured glass, and I was not incommoded. I saw, from this observation, that it was not impossible for a person used to the movement of a vessel, and accustomed to the use of large instruments, to observe, especially when the sea is calm, the immersions of the satellites of Jupiter with a telescope of 12 or 15 ft., which would have a large field, and to determine the time of those immersions in the above manner; for I believe myself safe in asserting that I did not make from them from 15 to 20 seconds in time of error on an immersion of the first satellite of Jupiter."

The observations made under these extraordinary circumstances, give for the total immersion of Venus, 8h. 27m. 56½s.; the commencement of the exit, 2h. 22m. 53s.; the total exit, 2h. 38m. 52½s., which gives for the duration, 6h. 10m. 55¾s., and for the time taken by the diameter to cross the limb of the sun, 15m. 59s. As M. de Seligny had observed at the Isle of France the exit of Venus, Le Gentil formed, for the meridian of his observation, 88° 20′ 15″ The log-book gave 87° 14′ 0″

As there was to be another transit of Venus on June 3, 1769, Le Gentil resolved to spend eight years in the southern hemisphere in wait for it. He had the devotion to carry this resolution into effect, spending his time in making a series of curious and interesting observations in the Mascarene Islands, Madagascar, Marianne Islands, the Philippines, and the coasts of India. He had fixed on Manilla as his place of observation, and reached it about August 1866, but he was ordered to return to Pondicherry. By what must seem a cruel fatality, this patient devotee of science, when the day of the Transit arrived, found his view of the sun completely shut out by clouds during the whole phenomenon, although for many days previous the sky had been cloudless. On the other hand, two friends whom he had left at Manilla were fortunate enough to witness the transit without obstruction. Le Gentil died on October 22, 1792.

ON THE TEMPORARY FADING OF SOME LEAVES WHEN EXPOSED TO THE SUN

FOR some time past I have taken much interest in this subject, since it at first seemed to indicate that chlorophyll in living plants could be decomposed by light in the same manner as when dissolved out from them by alcohol or other solvents. It also seemed to agree with the fact which I had established by comparative quantitative analysis, that leaves grown much exposed to the sun contain a relatively less amount of chlorophyll than those somewhat more shaded, in some cases even only one-third the quantity. My attention was first called to a diurnal change in the colour of a kind of moss commonly grown in hothouses, by Mr. Ewing, of the Sheffield Botanical Gardens, and subsequently to a similar change in a tropical species of maiden-hair fern, by Dr. Branson of Baslow. In both cases the colour of the fronds, after the darkness of night, was deep green, but after exposure to the bright sun of day it was a far paler and whiter green, which was again restored by the subsequent absence of light. I was particularly anxious to ascertain whether this change was due to a diminution in the amount of chlorophyll, but was unable to detect any well-marked difference by careful comparative quantitative analyses. I therefore came to the conclusion that, at all events in the case of the moss, the change in colour was due to some sort of mechanical alteration in the structure of the fronds, but did not examine the question more fully. The true explanation appears to be that adopted by Prillieux, who describes his observations in *Comptes Rendus*, t. lxxviii. p. 506. According to him and to the previous experiments of Famintzin and Borodin, exposure to bright light causes both granular and amorphous chlorophyll to collect together at the sides of the cells, instead of being more evenly distributed. The result of this is that a much larger relative proportion of white light is reflected, and the leaves or fronds appear of a paler and whiter green. These conclusions are thus in perfect agreement with my own quantitative analyses, and we may, I think, look upon this combined evidence of two independent methods as furnishing a satisfactory explanation of the greater part, if not of the whole, of the temporary change in colour.

H. C. SORBY

THE COMET

AFTER a very unusual amount of difficulty in the determination of the orbit I have succeeded in deducing a set of parabolic elements which appear to possess considerable precision. They are as follows:—

Perihelion passage, July, 8·83652 Greenwich M.T.

Longitude of Perihelion ...	271° 3′ 51″·5	Mean equinox July 0
" Ascending node ...	118 43 25·5	
Inclination to ecliptic ...	66 21 16·0	
Log. Perihelion distance ...	9·8298719	

Motion direct.

Our last observation, a very good one, gives this position:—

June 22, at 10h. 4m. 21s. M. T. at Twickenham.

R.A. ... 7h. 21m. 58·05s.

D. ... + 68° 9′ 34″·5

which compared with the above orbit (parallax and aberration allowed for) shows only the following insignificant differences—in R.A. − 2″; in D + 14″

This close agreement with parabolic motion is not favourable to identity of the comet with that of 1737 notwithstanding similarity of elements, but we must look to observers in the southern hemisphere to enable us to decide this point. The comet may certainly be there observed till October or November in the Antarctic circumpolar heavens.

The subjoined ephemeris will suffice to indicate the course of the comet, while it continues visible in our latitudes:—

AT GREENWICH—*Midnight.*

	R.A.	N.P.D.	Distance	Intensity of light.
	h. m.	° ′		
June 25	7 27·3	22 33	0·816	2·4
27	7 30·6	23 11	0·769	2·8
29	7 33·7	24 3	0·721	3·3
July 1	7 36·5	25 10	0·673	3·9
3	7 39·1	26 34	0·624	4·6
5	7 41·3	28 24	0·575	5·5
7	7 43·2	30 40	0·528	6·6
9	7 44·8	33 48	0·482	7·9
11	7 46·2	37 39	0·437	9·6
13	7 47·5	42 30	0·396	11·5
15	7 48·6	48 33	0·359	13·7

I have assumed the intensity of light on June 13 = 1.

The orbit of the comet makes a very close approach to that of the planet Venus. My last elements indicate for least distance of orbits 0·011.

For calculation of places after July 15 the following expressions for the comet's heliocentric co-ordinates referred to the equator, will be useful, in conjunction with X, Y Z, of the *Nautical Almanac*.

$$x = r\,[9{\cdot}77492]\,\sin(v + 26^\circ\ 8'{\cdot}5)$$
$$y = r\,[9{\cdot}98665]\,\sin(v + 276^\circ\ 17'{\cdot}1)$$
$$z = r\,[9{\cdot}92408]\,\sin(v + 176^\circ\ 54'{\cdot}5)$$

J. R. HIND

Mr. Bishop's Observatory, Twickenham, June 23

The following additional information is taken from a letter by Mr. Hind in yesterday's *Times*:—

"The comet will be nearest to the earth on the night of July 22, its distance being then less than 0·3.

"Last night at 11.30, the moon being yet above the horizon, the comet appeared to be in the least degree fainter than the star Upsilon, Ursæ Majoris, which Argelander estimates rather higher than the fourth magnitude. In the strongly illuminated sky of these midsummer nights it was very sensibly brighter than the neighbouring stars 42 and 43 Camelopardi. By measures of the nucleus taken with the filar-micrometer, it appeared to be rather more than 4,000 miles in diameter, and the tail, assuming it to be projected from the nucleus in the line of the radius-vector, would be 4,000,000 miles in length.

"During the first fortnight in July the comet will undoubtedly be a pretty conspicuous object in the constellation Lynx, where there are few bright stars.

"At the end of September its brightness, by theory, should be the same as on the night of discovery (April 17), and it will then be well observed in the southern hemisphere, in the neighbourhood of the star Alpha Chamæleontis."

MR. HIND, in a letter with which he has favoured me, lays great stress upon the star-like appearance of the nucleus of the comet now visible, as seen in a telecope; and M. Rayet has already, in a communication to the Paris Academy, shown that its spectrum is continuous, that of the coma giving the three ordinary cometary bands. On Monday evening last the comet was bright enough, in spite of the moonlight, to enable me to observe this continuous spectrum with my 6¼ inch Cooke and a pocket spectroscope. It struck me that the spectrum was short, *i.e.* that it was deficient in blue rays; and as one saw in the telescope a fan-like structure above the nucleus (as seen in an inverting telescope), so also in the spectroscope, the continuous spectrum sparkled as if many short bright lines or bands were superposed upon it. I shall be glad to learn that other observers with more powerful instruments have had their attention directed to these two points.

J. NORMAN LOCKYER

NOTES

ON the 3rd inst. the corner stone of the American Museum of Natural History in New York was laid by the President of the United States. The ground belonging to the Museum measures about eighteen acres, and the building when completed according to plan will be larger than the British Museum. The object of the Museum is twofold:—First to interest and instruct the masses; and secondly, and specially, to render all possible assistance to specialists. The library presented to the Museum by Miss Wolfe with a large collection of shells, also donated by Miss Wolfe to the Museum in memory of her father, who was its first President, was purchased by her at a cost of 35,000 dols. The other collections at present in the temporary Museum are valued at 250,000 dols. A rare and newly complete series of American birds, and many fine birds of Paradise and pheasants, now in the collection formerly belonging to Mr. D. G. Elliott, will be added. The Trustees have purchased the collection of Prince Maximilian, of Neuwied, on the Rhine, and a large number of specimens belonging to the late Edward Verreaux, of Paris. Large donations of shells, corals, and minerals, have been received, as also a collection of 20,000 insects. The collections will be bought and cared for by moneys contributed by the Trustees individually and the public, but the building now in progress will be erected at the expense of the city, which has already appropriated 500,000 dols. for this purpose.

Prof. Joseph Henry of the Smithsonian Institution gave an address on the above occasion, in which he spoke as follows on the necessity of endowing scientific research:—"The development of the institution would not be completed were it furnished with all the appliances I have mentioned. There is another duty which this city owes to itself and to the civilisation of the world. I allude to an endowment for the support of a college of discoverers and a number of men capable not only of expounding established and known truths, but of interrogating nature and discovering new facts, new phenomena, and new principles. The blindness of the public to the value of the abstract sciences and the matter of endowments of colleges for their support is remarkable. It is not everyone, however well educated he may be, that is capable of becoming a first-class scientist. Like poets, discoverers are born, not made, and when one of this class has been found he should be cherished, liberally provided with the means of subsistence, fully supplied with all the implements of information, and his life consecrated to the high and holy office of penetrating the mysteries of nature. What has been achieved in the knowledge of the forces in operation in nature, and the uses to which it is applied in controlling and directing these forces to useful purposes, constitutes the highest claim to the glory of our race.'

THE Duke of Devonshire, speaking at the banquet at Trinity College, Cambridge, on the 17th inst., said it had fallen to his lot during the last three or four years, while acting on a Royal Commission for inquiring into Scientific Education and the Advancement of Science, to become acquainted with the development and extension of scientific teaching in the several Universities of the kingdom, and of learning the views of those best qualified to express an opinion as to the requirements remaining to be supplied. The result of the inquiry had been satisfactory, inasmuch as it showed that a great deal had been done in the direction indicated, and that University authorities had manifested a strong desire that the Universities should be provided with all appliances necessary not only for centres of scientific education, but as centres also of general intellectual activity and of original research. This latter point was strongly insisted on in the evidence before the commissioners, and received their concurrence. A University which recognised the advancement and extension of knowledge as one of the main purposes of its existence was surely to be regarded as of a higher and nobler type than one which was satisfied with the position of a mere educational body. There was nothing antagonistic in these two objects; on the contrary, great advantage might be derived from their combination.

THE Emperor of Austria has been pleased to confer upon Mr. Robert H. Scott, F.R.S., the Director of the Meteorological Office, the Order of the Iron Crown, Third Class.

DR. TOL[illegible]AN, physician to the Shah of Persia, has been elected a corresponding member of the French Academy in the section of Medicine and Surgery, and M. Studer of Berne in that of Geology. The latter is a veteran of 79 years.

THE organisation of the French National Observatory will very soon be complete, *Les Mondes* says. The French Government have voted 30,000 francs to the meteorological department, and M. Le Verrier is about to resume the work of international meteorology, with the fixed intention of abandoning local meteorology to the departmental observatory of Mont-Souris. M. Le Verrier is at present in this country, having come over to get his Cambridge degree conferred. He is to visit Newcastle, to inspect Mr. Newall's large telescope, and Edinburgh and Glasgow in connection with meteorology. The printing has been begun of a very large catalogue of stars observed at the Paris Observatory. MM. Fizeau and Cornu are measuring anew the speed of light under conditions which encourage us to look for a definite result.

THERE will be ample opportunities for practical work in Natural Science during the long vacation (July and August) at Cambridge. The laboratories of Experimental Physics, of Chemistry and Physiology, will be open, and the professors, or the demonstrators, or both, will be in attendance to give assistance to students. Prof. Newton has given notice of a practical class for Comparative Anatomy; and Prof. Humphry has given notice of a practical class for Human Anatomy (more particularly Osteology), and also for Histology.

THE Rev. S. J. Perry, the head of the expedition sent out by the Admiralty to observe the transit of Venus, together with Lieut. Coke, R.N., Paymaster Brown, R.N., and the Rev. W. Sidgreaves, were among the passengers by the steamer *Windsor Castle*, which left Dartmouth on Tuesday for the Cape of Good Hope.

THE *conversazione* of the Society of Arts held in the South Kensington Museum last Friday was a great success. It is said there were about 3,500 guests present.

AT the annual meeting of the Palestine Exploration Fund, Lieut. Conder, R.E. (officer in charge of the survey of Palestine), described the work of the expedition. Before leaving Palestine he had completed half the map, and it was expected that within four years, instead of eight, the whole of Palestine would have been surveyed. There were now 300 square miles added to the map, being five times the result at first expected to be accomplished.

THE discovery of a new planet by Mr. Perrotin, of Toulouse, is announced.

AT the half-yearly meeting of the Highland and Agricultural Society of Scotland, a long discussion took place in reference to the filling up of the vacancy in the chemical department, as also on the proposal for granting bursaries with a view to the encouragement of agricultural education throughout the country. It was ultimately agreed to remit the matter back to the directors, with instructions to inquire as to the amount of funds that could be placed at their disposal for the educational and chemical departments. A motion for memorialising Government on the propriety of establishing agriculture as a branch of the system of physical science taught under the superintendence of the Department of Science and Art, and proposing that the Society offer a premium for the best text-book for such a course, was adopted.

IN reliance on the receipt of further subscriptions to prosecute the Sub-Wealden Exploration, it has been decided to continue the boring to a farther depth of 200 ft. The hon. secretary has offered to become personally responsible to the Diamond Rock Boring Company for the cost of the extra 200 ft. His offer has been accepted, and he has been requested to issue another appeal for subscriptions. In doing so he urges upon "all who like to be considered generous, enlightened, wise, and good, to vie with each other in contributing to complete this the first boring for scientific purposes in England."

AT the Anniversary Meeting of the Royal Geographical Society on Monday it was stated that there had been an increase of 342 new membering and 9 honorary corresponding members; the Society now numbers 2,900 Fellows. In accordance with the announcement already made, the Founder's Gold Medal was presented to Dr. Georg Schweinfurth, in whose absence it was received for him by the German Ambassador Count Münster; and the Victoria (or Patron's) Gold Medal, which had been awarded to Col. P. Egerton Warburton, for his journey across the previously unknown part of Western Australia, was received by his nephew, Mr. Bateman. Mr. Francis Galton, F.R.S., then introduced the successful competitors for the annual geographical medals. A gold medal for physical geography was awarded to Louis Weston (City of London School), and a bronze medal for the same subject to Francis Charles Montague (University College School). For political geography, a gold medal was gained by W. H. Turton (Clifton College, Bristol), and a bronze medal by Lionel Jacob (City of London School). The president, Sir Bartle Frere, then delivered his address on the progress of geography, and announced as his successor in the presidential chair, Major-Gen. Sir Henry C. Rawlinson, K.C.B. Medals were also given to Chumah and Susi, two of Livingstone's black servants, who brought his MSS. to England. The Rev. H. Waller stated they were of invaluable aid to Mr. T Livingstone in editing the MSS., both from their accurate knowledge of the country and their intelligent comprehension of the maps. At the anniversary dinner in the evening, among those who were present and who spoke were M. Leverrier and Chief-Justice Daley, President of the American Geographical Society.

THE fourth part of Tryon's "American Marine Conchology" has made its appearance, with eight coloured plates, and embracing the family of the *Chitonidæ*, of which six species are indicated, the orders *Opisthobranchiata* and *Pteropoda*, the commencement of the class *Acephala*, beginning with the *Pholadidæ*. The work was commenced early in 1873, and if it be confined to the five or six parts originally proposed, will soon be brought to a completion.

AT the annual distribution of the prizes in connection with the Newcastle College of Physical Science, on the 17th inst., the address of the Dean was, on the whole, very hopeful. The number of students has not greatly increased, but the quality of the work done has advanced considerably. We regret to see that the evening classes have not been so great a success as was hoped; but we hope the professors will not be easily induced to discontinue them, but will take every means to let their advantages be known to the young men of the district. During the past year the facilities of the college for imparting knowledge has been very much increased. The laboratory has been extended; a large and valuable collection of minerals has been added to Dr. Page's museum; and several expensive instruments have also been added to Mr. Herschel's collection. It is hoped that very soon a Chair of Biology will be established in the University. Arrangements have been made by which the degree of B.Sc. will be conferred on any deserving student by the University of Durham; and we are glad to see that the requirements for this degree have been made very considerable. Arrangements have also been made by which the college will be fully represented in the Senate of Durham.

A GEOLOGISTS' FIELD CLUB was instituted at Halifax at the close of the University lectures (Cambridge extension scheme) last April. The excursions which had been made from time to time with Mr. Sollas, B.A., made the students wishful to keep them up; hence the formation of a club which numbers about ninety members. The proceedings are reported in the local papers, and judging from the programme sent us the club means to go in for hard and earnest, and we hope fruitful, field-work.

IT gives us much pleasure to see from a recent number of the *Dunstable Borough Gazette* that that paper devotes a fair amount of space to science, under the title of "Our Science Column." The number before us, June 17, contains a good popular article on the value of scientific knowledge, some meteorological data, and an original communication on the botany of Dunstable, being the continuation of a list of plants of the district, with their common and scientific names. We hope the editor will continue his science column, and make it a means of enlightening his readers, and that the number of provincial papers which have a "Science Column" may go on rapidly increasing.

THE *Gardeners' Chronicle* learns that a committee has been formed, and funds are being collected, for the much needed restoration of Selborne Church as a memorial to Gilbert White. It is also proposed to erect a Cross to his memory on the "Plestor." It is hoped that a sufficient sum will be raised, beyond what will be required for these objects, to found an exhibition to one of the colleges at Oxford, with which he was connected, to be called the "Gilbert White" Exhibition. It is calculated that at least 5,000*l.* will be required. The committee includes the names of the Right Hon. Lord Selborne, the President and Fellows of Magdalen College, Oxon; Prof. Bell, F.R.S., &c.; the Rev. F. Parsons, Vicar of Selborne, and others.

AT a special meeting of the Anthropological Institute, to be held at Bethnal Green Museum, on July 1, Col. Lane Fox will give an Address on the principles of classification in his anthropological collection.

DR. LEA has added another volume to his large work on the Unionidæ, illustrated by twenty-two lithographic plates.

A PROPOSAL has been made in the *American Chemist* that a centenary meeting should be held on August 1 to commemorate the discovery of oxygen by Priestley on August 1, 1774. The *American Journal of Science and Arts* points out that this would afford an opportunity to discuss interesting chemical topics and to review the progress made during the century.

ON Wednesday the 17th the President of the Geological Society held an inaugural reception of the Fellows in their new apartments at Burlington House, to which many ladies were also invited. Although the meeting-room has been in use or a few weeks, and the removal of the library from Somerset House has been completed, the removal of the museum has but just commenced, and as the collections are so extensive it will occupy many weeks.

THE Statistical Society will hold its Fortieth Anniversary Meeting on Tuesday, June 30, at 3.30 P.M.

A PROJECT has been set on foot to provide Bridlington Quay with a marine aquarium. It is estimated the work will cost about 5,000*l.*, towards which several gentlemen in the locality have promised to subscribe. The affair will probably take the shape of a limited liability company.

THE additions to the Zoological Society's Gardens during the last week include two Huanacos (*Lama huanaco*) and a Patagonian Cavy (*Dolichotis patachonica*) from Patagonia, presented by Mr. W. G. Parry; a Common Racoon (*Procyon lotor*) from North America, presented by Mr. T Taylor; a Bonnet Monkey (*Macacus radiatus*) from India, presented by Mr. Wood; two Blue-cheeked Barbets (*Megalaema asiatica*) and two White Cranes (*Grus leucogeranus*) from India; a Honey Buzzard (*Pernis apivorus*), European, purchased; a Malay Tapir (*Tapirus indicus*) from Malacca, deposited.

CONFERENCE FOR MARITIME METEOROLOGY

THE Sub-committee for Maritime Meteorology appointed by the Permanent Committee of the Vienna Congress have determined to hold a private conference on the subject in London, to commence on Aug. 31. The meetings will be held, by permission of the meteorological committee, at the Meteorological Office, 116, Victoria Street, London, S.W. The invitations are to be issued this week, and the following is the Programme of Questions to be discussed. I may say that I have already received replies to the circular respecting the Brussels Conference from all the countries to which it was addressed.

ROBERT H. SCOTT,
Secretary to the Sub-Committee

A general wish has of late been expressed that the measures for the prosecution of Maritime Meteorology proposed at the International Conference at Brussels in 1853 should be reconsidered, now that the experience of more than twenty years of the operation of these measures has enabled meteorologists to form opinions as to their utility.

At the Meteorological Conference at Leipsig in 1872, and again at the International Congress at Vienna in 1873, preliminary discussions took place on the subject of the more successful prosecution of Ocean Meteorology. Certain resolutions were adopted at Leipsig and confirmed at Vienna, and accordingly it seems proper to embody them in the present programme. They run as follows:—

"1. Thorough uniformity in methods and instruments should be aimed at in the same measure as for observations on shore. This will be most satisfactorily obtained by the chiefs of the central institutes—the establishment of which in all countries in which they do not already exist, and in which the maritime interests demand them, must be declared as absolutely necessary—entering into relations with each other and agreeing on the separate details, the construction of the instruments, the hours of observation, the journal, &c.

"2. Unity of measures and scales is desirable, and to this end the introduction of millimetres for the barometer and the centigrade scale for the thermometer should be aimed at. While, however, the comparison of standard instruments of the individual central stations must be insisted on, the uniformity of scales is at present only declared as desirable.

"3. The Committee would urge the importance of the co-operation of the navies, inasmuch as by their assistance, and by the opportunities afforded thereby of completeness in certain observations, the determination of factors and constants is rendered possible, which can be used with advantage for the reduction of certain results derived from the general system of observations.

"4. With reference to the utilisation of the results, the Committee would urge similarly the importance of uniformity in the methods employed. In close relation therewith was the carrying out of the division of labour of the central stations of the individual states. This principle must be recognised as of the greatest importance for the further development of Marine Meteorology. The repetition of work over definite regions, with reference to the area to be investigated, must be declared as indefensible in the interests of this development."

It was further resolved—"That the convening of a Maritime Meteorological Conference is desirable."

While accepting the above resolutions as a general expression of the principles which should form the basis of an agreement as to future operations in the field of Ocean Meteorology, the Sub-Committee to whom the negotiations preparatory to the assembling of a Conference have been entrusted, consider that it is advisable to enter more minutely into the details, and have accordingly agreed on the following series of questions:—

In the case of a nation which sent any representative to the Brussels Conference in 1853, a circular should be addressed to the chief of the Office for Maritime Meteorology, if such exist, or to the chief of the meteorological organisation of the country, requesting him to state:—

1. To what extent the resolutions adopted at Brussels have been carried out in this country?

2. What have been the grounds for departure from them, if such departure has taken place?

and to send his reply to the Secretary to the Sub-Committee, Mr. Robert H. Scott, 116, Victoria Street, London, S.W., before June 1 next, in order to allow ample time to draw up a report on the replies for consideration at the Conference.

It seems advisable that, as above stated, the action taken at Vienna should be carefully reconsidered under several heads which will now be recapitulated.

I. *Observations.*—In respect of this subject it will be most convenient to take the "Abstract Log" of the Brussels Conference, and to discuss the several subjects of observation therein in the order of sequence of the columns.

Cols.	1 and 6.	Date and position of the observations.—Is it your opinion that a fresh column should be added, headed "Course and Distance by the Log in every Watch of four hours"?
,,	7 and 8.	Currents.
,,	9	Magnetic variation.—Is it desirable to give an additional column for the "Direction of Ship's Head"?
,,	10 and 11.	Wind, direction and force.—Is it possible to employ an anemometer at sea so as to give trustworthy results? Can the use of the Beaufort Scale be made universal?
,,	12 and 13.	Barometer.—To what degree of minuteness is it necessary to observe this instrument?
,,	14 and 15.	Thermometer—Dry bulb and wet bulb.—Should these observations be required from all ships?
,,	16.	Forms and direction of clouds.—Is this column sufficient, or should any notice be taken of more than one stratum of clouds?
,,	17.	Proportion of sky clear.—Is it not advisable to substitute for this heading "Proportion of sky clouded"?
,,	18.	Hours of rain, fog, snow, &c.—Is it desirable to retain this heading, or to substitute for it and No. 23 a column headed—"Weather by Beaufort Notation"?
,,	19.	State of the sea.—Should this be given according to a numerical scale?
,,	20.	Temperature of sea surface.
,,	21.	Specific gravity of sea surface.
,,	22.	Temperature at depths.—Is it desirable to retain these two last columns, or can the observations when taken be inserted in the column for "Remarks"?
,,	23.	Weather. See No. 18.
,,	24.	Remarks.

II. *Instruments.*—What patterns of instruments should be employed for any observations which may require them? Is there a reasonable possibility of introducing the metric and centigrade systems for general use at sea?

III. *Instructions.*—Is it possible to devise a general form of instructions to ensure uniformity in regard of methods of observation and registration?

IV. *Observers.*—What control should be exercised over the observers as to their instruments and registers? Is it desirable that all instruments employed should be the property of the central establishment, and *lent* to the observers?

V. *Co-operation of the Royal Navy.*—To what extent can ships of war assist in forwarding the ends of meteorological inquiry?

VI. *Discussion.*—Can general suggestions be thrown out as to the most profitable mode of discussion of the observations?

VII. *Subjects of Inquiry.*—To what extent can a division of labour as regards subjects of inquiry be carried out in a spirit of fairness to the collecting and discussing establishments respectively?

VIII. *Sailing Directions.*—In how far are purely practical investigations, such as the preparation of sailing directions, admissible for a scientific institution?

Any gentleman into whose hands this programme may come, and who is himself not likely to attend the Conference, is requested to forward any remarks he may wish to make on any of the subjects mentioned herein to Mr. Scott, at the above address, before July 1, 1874.

SCIENTIFIC SERIALS

THE *Journal of the Chemical Society* for May contains the following papers communicated to the Society:—On the action of bromine on alizarin, by W. H. Perkin. Alizarin heated in a sealed tube with a solution of bromine in carbon disulphide yields monobromalizarin, $C_{14}H_7BrO_4$. This latter substance heated with acetic anhydride gives diacetobromalizarin, $C_{14}H_5Br(C_2H_3O)_2O_4$, and with nitric acid a mixture of phthalic and oxalic acids, while free bromine is given off. Specimens of cotton prints showing the difference in the shade of colour produced by alizarin and bromalizarin when used as dyeing materials accompany the paper. Note on the action of trichloracetyl chloride upon urea, by Raphael Meldola and Donato Tommasi. The authors have obtained trichloracetyl urea $CO\left\{\begin{matrix} NH(C_2Cl_3O) \\ NH_2 \end{matrix}\right.$.—Researches on the action of the copper-zinc couple on organic bodies. Part V. On the bromides of the olefines; and Part VI. On ethyl bromide, by Dr. J. H. Gladstone and A. Tribe. The couple acts upon dry ethylene bromide, producing ethylene by double decomposition; in presence of alcohol the decomposition is explosive. The action of the couple is the same either in presence of alcohol or water, and the fact that these substances facilitate the action is explained by the authors by the solvent action of these liquids on the film of zinc bromide formed on the surface of the couple. Propylene and amylene bromides are decomposed in a similar manner, yielding the corresponding olefines. With regard to the action of the couple on ethyl bromide the authors are of opinion that ethylo-bromide of zinc $\left.\begin{matrix} C_2H_5 \\ Br \end{matrix}\right\}Zn$ is always formed, and this on further heating produces zinc ethyl and zinc bromide or two semi-molecules of ethyl may decompose with the formation of ethane and ethylene. In presence of water or alcohol ethane is always produced according to the reactions:—

$$\left.\begin{matrix} C_2H_5 \\ Br \end{matrix}\right\}Zn + H_2O = \left.\begin{matrix} HO \\ Br \end{matrix}\right\}Zn + C_2H_6$$

$$\left.\begin{matrix} C_2H_5 \\ Br \end{matrix}\right\}Zn + \left.\begin{matrix} C_2H_5 \\ H \end{matrix}\right\}O = \left.\begin{matrix} C_2H_5O \\ Br \end{matrix}\right\}Zn + C_2H_6$$

—The agglomeration of finely-divided metals by hydrogen, by Alfred Tribe. Copper, palladium, and platinum in a finely-divided state agglomerate when hydrogenised. By way of hypothesis the author suggests that the minute particles of the metals are surrounded by layers of liquid hydrogen which coalesce.—The last paper is by Andrew Fuller Hargreaves On the spontaneous combustibility of charcoal. The maximum amount of oxygen is absorbed from the atmosphere within three days after carbonisation, so that from that time charcoal may be used for gunpowder without danger, but up to that period spontaneous combustion is liable to occur. About three-fourths of the journal is devoted to foreign abstracts.

Transactions of the Manchester Geological Society, vol. xiii. Part IV.—The papers in this part are the following:—On coal-cutting machinery, by Mr. W. H. J. Traice; Additional notes on the millstone grit of the parish of Halifax, by Mr. James Spencer; On Permian and Trias, by Mr. E. W. Binney, F.R.S.; On Pleistocene mammalia found near Castleton, Derbyshire, by Mr. J. Plant, F.G.S.

Proceedings of the Geologists' Association, vol. iii. No. 5.—Besides an account of some of the excursions made by the Association during 1873 the number contains the following papers, abstracts of which have been given in our reports of the Society's proceedings:—On some fossils from the Margate chalk, by J. W. Wetherell, with illustrations; On the valley of the Vézère, Périgord, its limestones, caves, and Prehistoric remains, by Prof. T. Rupert Jones, F.R.S.; On ammonite zones in the Isle of Thanet, by F. A. Bedwell. The last-mentioned occupies a large part of the number, and is illustrated.

Bulletin of the Essex (Salem, U.S.) Institute, vol. iv., 1872.—The principal papers in the *Bulletin* of this very efficient Institute for 1872 are a communication from Mr. S. A. Nelson On the Meteorology of Mount Washington, the main purpose of which is to show the advantages for meteorological purposes mountain-stations offer over those less elevated; and a "Catalogue of the Mammals of Florida, with notes on their Habits, Distribution," &c., by C. J. Maynard.—The *Bulletin* for 1873 contains more papers of scientific interest than that of the previous year.—The first paper is a short one, by Dr. A. S. Packard, On the glacial phenomena of north-east America compared with those of Europe.—There is a short but interesting statement by Mr. J. H. Emerton of the results of his observations on worms of the genus *Nais*.—Mr. S. M. Allen contributes a paper On ancient and modern theories of light, heat, and colour.—Mr. H. Herrick contributes a Partial Catalogue, of considerable length, of the birds of Grand Menan, N.B.—Mr. F. W. Putnam has a paper on the various forms of cutting instruments made of stone.—"Notes on the bird-fauna of the Salt Lake Valley and the adjacent portions of the Wahsatch Mountains," is the title of a long paper by Mr. R. Ridgway, who also contributes a paper on the birds of Colorado, and, along with Mr. S. F. Baird, one on some new forms of American birds.—There are also interesting accounts of the numerous and profitable excursions made during the summer months by the Institute.—There is a very minute account of the celebration of the 25th anniversary of the Institute on March 5, 1873. Many well-known scientific men were present, and among others Prof. O. C. Marsh, who paid the high compliment to the Institute that through its influence the botany and zoology of Essex county were better understood than those of any other county in the United States. It was at the hands of the Essex Institute, he said, that he himself acquired his taste for scientific investigation.

Poggendorff's Annalen der Physik und Chemie, No. 3, 1874.—This number commences with a translation of Dr. Draper's recent paper on photography of the diffraction spectrum (which has already appeared in our columns).—The conductivity of flame for galvanic currents is known to be greatly exalted by presence of metallic vapours, and M. Herwig was led to inquire whether a gaseous layer, entirely formed of such vapours, would not show good conductivity even at low temperatures. He experimented with mercury, dense vapours of which can be had several hundred degrees under white heat. The vapour conductivity he finds to resemble that of the voltaic arc, rather than that of a simple metallic conductor. There is a peculiar transition-resistance, which is great in comparison with the hindrances which the current finds within the vapour-layer itself; so that the total resistance is in great measure independent of the extent of the vapour-layer. The transition-resistance is less with increased electromotive force of battery or strength of current. Further, the vaporisation in the positive mercury surface was increased by the current; another point of analogy to the voltaic arc (in which, if the electrodes be mercury and platinum, the mercury is vaporised only when it forms the positive pole); and, using a platinum point and a mercury surface, the resistance of the vapour (like that of the arc) was greater when the mercury surface was positive.—M. Friedrich Müller concludes his investigation on galvanic polarisation and the distribution of the current in electrolytes. He states that, with copper plates in dilute sulphuric acid, and also in a solution of sulphate of copper mixed with sulphuric acid, the polarisation follows a simple law: it is a linear increasing function of the density of current. Another observation of the author is that cupric oxide is reduced to copper by galvanic hydrogen (confirming previous observations that galvanic hydrogen is considerably more active than ordinary hydrogen).—The galvanic conductivity of sulphuric acid and muriatic acid, and its dependence on temperature, is the subject of a communication from M. Grotrian.—In pursuing his researches on the compressibility of elastic fluids M. Regnault did not experiment with pressures lower than one atmosphere. The difficulty of the inquiry has perhaps deterred physicists since. We here find it undertaken, however, by M. Siljeström, who contributes a paper on the subject; in the first part here given the details of apparatus are fully described, and the numerical results of some sixteen series of experiments tabulated.—M. Schneider communicates a ninth paper on new salts of sulphur, and M. Kessler describes "the simple euthyoptic spectroscope."—Among matter from other journals we note a valuable paper by M. Boltzmann, On experimental determination of the dielectricity constants of insulators.

Astronomische Nachrichten, No. 1,905.—This number contains a large number of observations of position, taken at Leipsig, of some of the minor planets Comet II. (Tempel), Comet III. (Borelly), Comet IV (Henry), and Comet VII. (Coggia); also the mean planes of sixty-nine variable stars for the year 1873. Prof. d'Arrest sends his observations on the position of Coggia's comet, taken during May last. An astronomical prize is offered by the Academy at Copenhagen for research on the data of the ancients comprised between the time of Ptolemy and the eighteenth century The discovery of a new planet is anounced from Toulouse by Mr. Perrotin, May 10, 10 P.M. R.A. 10h. 28m. 30s., D. 22' 48 No. 1,906 contains a discussion of the errors of levels due to the change of direction of attraction acused by the spheroidal figure of the earth and other local causes, and Prof. Spœrer gives the results of his sun-spot and protuberance observations for April and May last.

Abhandlungen der Schlesischen Gesellschaft für Vaterländische Cultur, 1872-73.—Dr. Grätzer here furnishes a number of social statistics regarding Breslau gathered from the census made in December of that year. From a comparison with Berlin, the population of which (825,389) was then nearly four times that of Breslau, it appears that Breslau is less crowded; there being in it a dwelling-house to every 38·9 of the inhabitants, whereas in Berlin the proportion is 1 to every 56·9. On the whole it appears that, notwithstanding the better proportion of dwellings in Breslau, the health of the two cities is nearly alike, Breslau having counterbalancing disadvantages in bad buildings, sites, drinking and underground water, and soil.—M. Limpricht contributes a report on the watershed between Weide and Bartsche, with a list of the plants found in that region.

Verh. der k.k. zool. bot. Gesellschaft in Wien, 23ter Band, 1873.—This volume, of more than 600 closely-printed pages, is chiefly occupied by papers on entomology and botany. Among the most important are:—*Insecta.*—Contributions to the Orthoptera of the Tyrol: Krauss; Diptera collected in Galicia; Hymenoptera: Kriechbaumer; Microlepidoptera of Leghorn, by J. Mann; Contributions to the nocturnal Lepidoptera of North America, by Prof. Zeller (second part) with figures: more than a hundred new species are described; Contributions to the Phryganidæ, by Dr. Hagen of Cambridge, U.S.; Hungarian Diptera: Kowarz; Eight new German species of Diptera: Beling; New butterflies from Asia Minor; On certain species of Tipula and its allied genera: Beling.—*Crustacea.*—On *Lepidurus lubbockii* and the Phyllopoda.—*Vertebrata.*—A graphic account of the breeding and habits of the Pelican on the Danube. Beside *P. onocrotalus* and *P. crispus*, *P. minor* was also found. On *Comephorus baicalensis*, a fish allied to the genus *Cottus*, with two figures: Dybowski.—*Mollusca.*—Contributions to the genus *Acolidia* and its allies, by Dr. Bergh of Copenhagen.—*Botany.*—Contributions to the flora of Lower Austria, by Von Reuss, jun.; Lichens of the Tyrol, by F. Arnold; Fauna of the Brdygebirg in Bohemia; Fungi of south-east Hungary, by Prof. Harslinsky; The flora of the state districts in the south-east of Lower Austria: Woloszczak; Contributions to the flora of Lower Austria, by Hackel. The volume contains a photographic portrait of the late Secretary of the Society, Ritter von Frauenfeld, with his latest contributions to Entomology and a biographical notice, by Von Wattenwyl.

Reale Istituto Lombardo. Rendiconti: t. vii., Fasc. i. e ii.—These parts contain the following papers:—Prof. Serpieri communicates his observations of the meteor shower of August 10, 1873, made at Urbino.—Observations concerning the constitutions and combinations of bodies, a paper on molecular physics, by Dr. Guido Grassi.—On a fact of importance in silkworm culture, by Prof. G. Balsamo Crivelli.—Prof. Cesare Lombroso tabulates the height and weight, cranial measurements and capacities, facial angle, &c., of 832 Italian prisoners, dividing them into homicides, thieves, highwaymen, incendiaries, tricksters, deserters, &c. These prisoners were Sicilian, Sardinian, Calabrian, Neapolitan, Piedmontese, Genoese, and Lombardian. The results are discussed in great detail.—Prof. Antonio Bucellati contributes a paper on political economy, entitled "On the theory of capital."

SOCIETIES AND ACADEMIES

London

Royal Society June 11.—Spectroscopic Notes.—On the Evidence of Variation in Molecular Structure, by J. N. Lockyer, F.R.S.

1. In an accompanying note I have shown that when different degrees of dissociating power are employed the spectral effects are different.

2. In the present note I purpose to give a preliminary account of some researches which have led me to the conclusion that, starting with a mass of elemental matter, such mass of matter is continually broken up as the temperature (including in this term the action of electricity) is raised.

3. The evidence upon which I rely is furnished by the spectroscope in the region of the visible spectrum.

4. To begin by the extreme cases, all solids give us continuous spectra; all vapours produced by high tension spark give us line spectra.

5. Now the continuous spectrum may be, and as a matter of fact is, observed in the case of chemical compounds, whereas all compounds known as such are resolved by the high tension spark into their constituent elements. We have a right, therefore, to assume that an element in the solid state is a more complex mass than the element in a state of vapour, as its spectrum is the same as that of a mass which is known to be more complex.

6. The spectroscope supplies us with intermediate stages between these extremes.

(α) The spectra vary as we pass from the induced current with jar, to the spark without the jar, to the voltaic arc, or to the highest temperature produced by combustion. The change is always in the same direction; and here again the spectrum we obtain from elements in a state of vapour, a spectrum characterised by spaces and bands, is similar to that we obtain from vapours of which the compound nature is unquestioned.

(β) At high temperatures the vapours of some elements (which give us neither line nor channelled-space spectra at those temperatures, although we undoubtedly get line spectra when electricity is employed, as stated in No. 4), give us a continuous spectrum at the more refrangible end, the less refrangible end being unaffected.

(γ) At ordinary temperatures, in some cases, as in selenium, the more refrangible end is absorbed; in others the continuous spectrum in the blue is accompanied by a continuous spectrum in the red. On the application of heat the spectrum in the red disappears, that in the blue remains; and further, as Faraday has shown in his researches on gold-leaf, the masses which absorb in the blue may be isolated from those which absorb in the red. It is well known that many substances known to be compounds in solutions, give us absorption in the blue or blue and red, and also that the addition of a substance known to be compound (such as water) to substances known to be compound which absorb the blue, superadds an absorption in the red.

7. In those cases which do not conform to what has been stated the limited range of the visible spectrum must be borne in mind. Thus I have little doubt that the simple gases at the ordinary conditions of temperature and pressure have an absorption in the ultra-violet; that highly compound vapours are often colourless because their absorption is beyond the red, with or without an absorption in the ultra-violet. Glass is a good case in point; others will certainly suggest themselves as opposed to the opacity of the metals.

8. If we assume in accordance with what has been stated that the various spectra to which I have referred are really due to different molecular aggregations, we shall have the following series, going from the more simple to the more complex.

First stage of complexity of molecule.	Line spectrum.
Second stage	Channelled-space spectrum.
Third stage	Continuous absorption at the blue end, not reaching to the less refrangible end. (This absorption may break up into channelled spaces.)
Fourth stage	Continuous absorption at the red end, not reaching to the more refrangible end. (This absorption may break up into channelled spaces.)
Fifth stage	Unique continuous absorption.

9. I shall content myself in the present note by giving one or two instances of the passage of spectra from one stage to another, beginning at the fifth stage.

From 5 to 4

1. The absorption of the vapours of K in the red-hot tube, described in another note, is at first continuous. As the action of the heat is continued, this continuous spectrum breaks in the middle, one part of it retreats to the blue, the other to the red.

From 4 to 3

1. Faraday's researches on gold leaf best illustrate this, but I hold that my explanation of them by masses of two degrees of complexity only, is sufficient without his conclusion ("Researches in Chemistry," p. 417), that they exist "of intermediate sizes or proportions."

From 3 to 2

1. Sulphur vapour first gives a continuous spectrum, at the blue end, on heating this breaks up into a channelled-space spectrum.

2. The new spectra of K and Na (more particularly referred to in the following note) make their appearance after the continuous absorption in the blue, and red vanishes.

From 2 to 1

1. In many metalloids the spectra without the jar are channelled; on throwing the jar into the circuit the line spectrum is produced, while the cooler exterior vapour gives a channelled absorption-spectrum.

2. The new spectra of K and Na change into the line-spectrum (with thick lines which thin subsequently) as the heat is continued.

Spectroscopic Notes.—On the Molecular Structure of Vapours in connection with their Densities, by J. N. Lockyer, F.R.S.

1. I have recently attempted to bring the spectroscope to bear upon the question whether vapours of elements below the highest temperatures are truly homogeneous, and whether the vapours of different chemical elements at any one temperature are all in the same molecular condition. In the present note I beg to lay before the Royal Society the preliminary results of my researches.

2. We start with the following facts:—

I. All elements driven into vapour by the induced current give line-spectra.

II. Most elements driven into vapour by the voltaic arc give us the same.

III. Many metalloids when greatly heated, some at ordinary temperatures, give us channelled space-spectra.

IV. Elements in the solid state give us continuous spectra.

3. If we grant that these spectra represent to us the vibrations of different molecular aggregations, and this question is discussed in another the previous (note) spectroscopic observations should give us facts of some importance to the inquiry.

4. To take the lowest ground. If, in the absence of all knowledge on the subject, it could be shown that all vapours at all stages of temperature had spectra absolutely similar in character, then it would be more likely that all vapours were truly homogeneous and similar among themselves as regards molecular condition than if the spectra varied in character, not only from element to element, but from one temperature to another in the vapour of the same element.

5. At the temperature of the sun's reversing layer the spectra of all the elements known to exist in that layer are apparently similar in character, that is they are all line spectra; hence it is most probable that the vapours there are truly homogeneous and that they all exist in the same molecular condition, than if the spectrum were a mixed one.

6. The fact that the order of vapour densities in the sun's atmosphere which we can in a measure determine by spectroscopic observations does not agree with the order of the modern atomic weights of the elements, but more closely agrees with the older atomic weights, led me to take up the present research. Thus I may mention that my early observations of the welling up of Mg vapour all round the sun *above the Na vapour*, have lately been frequently substantiated by the Italian observers. So that it is beyond all question, I think, that *at the sun* the vapour density of Mg is less than that of Na.

7. The vapour densities of the following elements have been experimentally determined:—

H	1	S	32 (at 1,000°)
K	39	I	127
As	150	Hg	100
Br	80	N	14
Cd	56	O	16
Cl	35·5	P	62

8. To pursue this inquiry the following arrangements have been adopted:—

The first experiments were made last December upon Zn in a glass tube closed at each end with glass plates; and I have to express my obligations to Dr. Russell for allowing them to be conducted in his laboratory, and for much assistance and counsel concerning them.

A stream of dry H was allowed to pass. The tube was heated in a Hofmann's gas furnace, pieces of the metal to be studied having previously been introduced. It was found that the glass tube melted; it was therefore replaced by an iron one. The inconvenience of this plan, however, owing to the necessity for introducing the metal into the end of the hot tube when the first charge had volatilised, and moreover the insufficiency of the heat obtainable from the gas furnace, soon obliged me to replace both tube and furnace by others, which have now been in use for many weeks, and which still continue to work most satisfactorily.

The iron tube is 4 ft. in length, and is provided with a central enlargement, suggested to me by Mr. Dewar, forming a T-piece by the screwing in of a side tube, the end of which is left projecting from the door in the roof of the furnace. Caps are screwed on at each end of the main tube; these caps are closed by a glass plate at one end, and have each a small side tube for the purpose of passing hydrogen or other gases through the hot tube. The furnace is supplied with coke or charcoal, an electric lamp connected with thirty Grove's cells is placed at one end of the tube and a one-prism spectroscope at the other. The temperatures reached by this furnace may be conveniently divided into four stages:—

I. When the continuous spectrum of the tube extends to the sodium line D, this line not being visible.

II. When the continuous spectrum extends a little beyond D, this line being visible as a bright line.

III. When the spectrum extends into the green, D being very bright.

IV. When the spectrum extends beyond the green and D becomes invisible as a line, and the sides of the furnace are at a red heat.

I may add (1) that I have only within the last few days been able to employ the third and fourth stages of heat, as the furnace was previously without a chimney, and the necessary draught could not be obtained; and (2) that I was informed a little time ago by Prof. Roscoe that with a white-hot tube he had observed new spectra in the case of Na and K. These spectra which I now constantly see, when these temperatures are reached, I shall call the "new spectra."

9. The results of the experiments, so far as the visible spectrum is concerned, between the stages indicated, may be stated as follows:—

H No absorption.

N ,, ,,

K I have observed either separately or together.
- (α) The line absorption line near D.
- (β) Continuous absorption throughout the whole spectrum.
- (γ) Continuous absorption in red and blue at the same time, the light being transmitted in the centre of the spectrum (as by gold-leaf).
- (δ) Continuous absorption clinging on one side or other of the line. (This phenomenon which, so far as I know, is quite new, will be described in another note.)
- (ε) The new spectrum.

Na I have observed either separately or together
- (α) D absorbed.
- (β) Continuous absorption throughout the whole spectrum.
- (γ) Continuous absorption clinging on one side or the other of D.
- (δ) The new spectrum.

Zn Continuous absorption in the blue. (An unknown line sometimes appears in the green, but certainly no line of Zn.)

Cd Continuous absorption in the blue.

Sb New spectrum with channelled spaces and absorption in the blue.

P The same. (This, however, in consequence of the extreme delicacy of the spectrum requires confirmation.)

S Channelled-space spectrum (previously observed by Salet).

As Probable channelled-space spectrum. (Observations to be repeated.)

Bi No absorption.

I Channelled spectrum in the green and intense bank of general absorption in the violet, where at the ordinary temperature the vapour transmits light.

Hg No absorption.

10. These results may be tabulated as follows:—

	V.d.	Modern atomic weight.	
H	1	1	No visible absorption.
K	39	39	Line absorption.
As	150	75	Probable channelled space absorption.
Cd	56	112	Continuous absorption in the blue.
I	127	127	Channelled-space absorption + band of absorption in violet
Hg	100	200	No absorption.
N	14	14	,, ,,
O	16	16	Not observed.
P	62	31	Channelled-space spectrum probable.
Na	(?)	23	Line absorption.
Zn	(?)	65	Continuous absorption in the violet.
Sb	(?)	122	Channelled-space spectrum and absorp. in the blue.
S	32	32	Channelled-space spectrum.
Bi	(?)	208	No absorption.

11. It will be seen from the foregoing statement that if similar spectra be taken as indicating similar molecular conditions, then the vapours, the densities of which have been determined, have not been in the same molecular condition among themselves. Thus the vapours of K, S, and Cd at the fourth stage of heat gave us line, channelled space, and continuous absorption in the blue, respectively. This is also evidence that each vapour is non-homogeneous for a considerable interval of time, the interval being increased as the temperature is reduced.

On the alleged Expansion in Volume of various substances in passing by Refrigeration from the state of Liquid Fusion to that of Solidification, by Robert Mallet, F.R.S.

Since the time of Reaumur it has been stated with very various degrees of evidence, that certain metals expand in volume at or near their points of consolidation from fusion. Bismuth, cast-iron, antimony, silver, copper, and gold are amongst the number, and to these have recently been added certain iron-furnace slags. Considerable physical interest attaches to this subject from the analogy of the alleged facts to the well-known one that water expands between 30° F. and 32°, at which it becomes ice; and a more extended interest has been given to it quite recently by Messrs. Nasmyth and Carpenter having made the supposed facts, more especially those relative to cast-iron and to slags, the foundation of their peculiar theory of lunar volcanic action as developed in their work "The Moon as a Planet, as a World, and a Satellite" (4to, London, 1874). There is considerable ground for believing that bismuth does expand in volume at or near consolidation; but with respect to all the other substances supposed to do likewise, it is the object of this paper to show that the evidence is insufficient, and that with respect to cast-iron and to the bassic silicates constituting iron slags, the allegation of their expansion in volume, and therefore their greater density when molten than when solid, is wholly erroneous. The determination of the specific gravity in the liquid state of a body having so high a fusing temperature as cast-iron is attended with many difficulties. By an indirect method, however, and operating upon a sufficiently large scale, the author has been enabled to make the determination with considerable accuracy. A conical vessel of wrought iron of about 2 ft. in depth and 1·5 ft. diameter of base, and with an open neck of 6 in. in diameter, being formed, was weighed accurately empty, and also when filled with water level to the brim; the weight of its contents in water, reduced to the specific gravity of distilled water at 60° F. was thus obtained. The vessel, being dried, was now filled to the brim with molten grey cast-iron, additions of molten metal being made to maintain the vessel full until it had attained its maximum temperature (yellow heat in daylight) and maximum capacity. The vessel and its contents of cast-iron when cold were weighed again, and thus the weight of the cast-iron obtained. The capacity of the vessel when at a maximum was calculated by applying to its dimensions at 60° the coefficient of linear dilatation, as given by Laplace and others, to its range of increased temperature; and the weight of distilled water held by the vessel thus expanded was calculated from the weight of its contents when the vessel and water were at 60° F. after applying some small corrections.

We have now the elements necessary for determining the specific gravity of the cast-iron which filled the vessel when in the molten state, having the absolute weights of equal volumes of distilled water at 60° and of molten iron. The mean specific gravity of the cast-iron which filled the vessel was then determined by the usual methods. The final result is that, whereas the specific gravity of the cast-iron when cold was 7·170 it was only 6·650 when in the molten condition; cast-iron, therefore, is less dense in the molten than in the solid state. Nor does it expand in volume at the instant of consolidation, as was conclusively proved by another experiment. Two similar 10-inch spherical shells 1·5 in. in thickness, were heated to nearly the same high temperature in an oven, one being permitted to coo empty as a measure of any permanent dilatation which both might sustain by mere heating and cooling again, a fact well known to occur. The other shell, when at a bright red heat, was filled with molten cast-iron and permitted to cool, its dimensions being taken by accurate instruments at intervals of thirty minutes, until it had returned to the temperature of the atmosphere (53° F.), when, after applying various corrections, rendered necessary by the somewhat complicated conditions of a spherical mass of cast-iron losing heat from its exterior, it was found that the dimensions of the shell whose interior surface was in perfect contact with that of the solid ball which filled it were, within the limit of experimental error, those of the empty shell when that also was cold (53° F.), the proof being conclusive that no expansion in volume of the contents of the shell had taken place, which was further corroborated by the fact that the central portion was found much less dense than the exterior, whereas if the cast-iron expanded in consolidating the central portions must be more dense than the exterior.

It is a fact, notwithstanding what precedes and well known to iron-founders, that certain pieces of cold cast-iron do float on molten cast-iron of the same quality, though they cannot do so through their buoyancy, as various sorts of cast-iron vary in specific gravity at 60° F., from nearly 7·700 down to 6·300, and vary also in dilatability; that thus some cast-irons may float or sink in molten cast-iron of different qualities from themselves through buoyancy or negative buoyancy alone; but where the cold cast-iron floats upon molten cast-iron of less specific gravity than itself, the author shows that some other force, the nature of which yet remains to be investigated, keeps it floating; this the author has provisionally called the repellent force, and has shown that its amount is, *cæteris paribus*, dependent upon the relation that subsists between the volume and "effective" surface of the floating piece. By "effective" surface is meant all such part of the immersed solid as is in a horizontal plane, or can be reduced to one. The repellent force has also relations to the difference in temperature between the solid and the molten metal on which it floats.

The author then extends his experiments to lead, a metal known to contract greatly in solidifying, and with respect to which there is no suggestion that it expands at the moment of consolidation. He finds that pieces of lead having a specific gravity of 11·361 and being at 70° F. float or sink upon molten lead of the same quality, whose calculated specific gravity was 11·07, according to the relation that subsisted between the volume and the "effective" surface of the solid piece, thin pieces with large surface always floating, and *vice versa*. An explanation is offered of the true cause of the ascending and descending currents observed in very large "ladles" of liquid cast-iron, as stated by Messrs. Nasmyth and Carpenter. The facts are shown to be in accordance with those above mentioned, and when rightly interpreted to be at variance with the views of these authors.

Lastly, the author proceeds to examine the statements made by these authors, as to the floating of lumps of solidified iron-furnace slag upon the same when in a molten state; he examines the conditions of the alleged facts, and refers to his own experiments upon the total contraction of such slags, made at Barrow Ironworks, and a full account of which he has given in his paper On the true nature and origin of volcanic heat and energy, printed in Phil. Trans. 1873, as conclusively proving that such slags are not denser in the molten than in the solid state, and that the floating referred to is due to other causes. The author returns thanks to several persons for facilities liberally afforded him in making these experiments.

Chemical Society, June 18.—Prof. Frankland, F.R.S., vice-president, in the chair.—The following papers were read:—On the action of chlorine, bromine, &c., on isodinapthyl, by W. Smith.—Dr. Armstrong then read four communications from the laboratory of the London Institution, No. XIII. On coal-tar cresol and some derivatives of paracresol, by H. E. Armstrong, and C. L. Field; No. XIV. On the action of the chlorides of the acids of the sulphur series on organic compounds, by H. E. Armstrong and W. H. Pike; No. XV. On chloro, bromo, and iodo-nitrophenolparasulphonic acids, by H. E. Armstrong and F. D. Brown; and No. XVI. Note on the decomposition of dichloronitrophenol by heat, by H. E. Armstrong and F. D. Brown.—The sixth paper was by Mr. F. Neison, On the products of the decomposition of castor oil, No. III. On decomposition by excess of alkaline hydrate, in which he has succeeded in elucidating the conflicting statements of different chemists on this subject.—On hydrogen persulphide, by Dr. W. Ramsay.—Suberone, by Dr. C. Schorlemmer and Mr. R. S. Dale.—On the action of nitrosyl chloride on organic bodies. Part I.—On phenol, by Dr. W. A. Tilden.—An apparatus for determining the moisture and carbonic anhydride in the atmosphere; A method for determining ozone in the presence of chlorine and nitric oxide; and On the constitution of urea, by Dr. D. Tommasi.—On the restitution of burnt steel, by Mr. S. L. Davies.—On the action of earth on organic nitrogen, by Mr. E. C. Stanford.—Aniline and its homologues in coal-tar oils, by Mr. W. Smith.

Zoological Society, June 16.—Dr. A. Günther, vice-president, in the chair.—An extract was read from a letter received from Dr. A. B. Meyer, concerning two birds (*Rectes bennetti* and *Campephaga aurulenta*) lately described in the Society's Proceedings by Mr. Sclater.—A letter was read from Mr. William Summerhayes, relating to certain species of Curassows found in Venezuela.—Dr. J. Murie read a paper on the nature of the sacs vomited by the Hornbills, which he stated, in confirmation of Prof. Flower's account of these objects, to consist of the epithelial lining of the stomach.—Mr. W. Saville Kent, F.L.S., communicated a second paper upon the gigantic cephalopods recently encountered off Newfoundland. From further information received, Mr. Saville Kent apprehended that it would be necessary to refer the two individuals preserved in St. John's Museum to the genus *Ommatostrephes*, thus avoiding the institution of a new genus for their reception, as proposed in his former paper.—Mr. A. H. Garrod read a paper on the "showing off" of the Australian Bustard (*Eupodotis australis*) and pointed out the peculiar structures by which this "showing off" was accomplished.—A communication was read from Dr. F. Stolicza, containing a description of the *Ovis polii* of Blyth, of which he had lately obtained specimens in Yarkand.—Mr. R. B. Sharpe read a paper on a new genus and species of Passerine birds from the West Indies, which he proposed to name *Phœnicomanes iora*.—A communication was read from the Rev. O. P. Cambridge, containing descriptions of some new species of Spiders of the genus *Erigone* from North America.—Dr. Günther read a paper describing some new species of reptiles from the Camaroon Mountains, West Africa. Amongst these were two new species of Chameleon, and a new snake of the family of Lycodontidæ, proposed to be called *Bothrolycus ater*. One of these Chameleons was referred to a new subgenus (*Rhampholeon*), being remarkable for its abbreviated tail and the development of a denticle at the inner base of each claw.—Mr. Sclater read a paper containing a description of three new species of the genus *Synallaxis* from M. Jelski's collections in Central Peru, which he proposed to call *S. Pudibunda*, *S. graminicola*, and *S. virgata*.—Messrs. H. P. Blackmore and E. R. Alston communicated a joint paper on the Arvicolidæ which have hitherto been found in a fossil state.—Prof. Newton read an account of a living Dodo shipped for England in the year 1628, extracted from letters in the possession of Dr. J. B. Wilmot, of Tunbridge Wells.—Mr. J. E. Harting read a paper on the common Lapwing of Chili, which he proposed to separate from *Vanellus cayanensus*, under the name *V. occidentalis*.—A second paper read by Mr. Harting contained an account of the eggs of some new or little-known Limicolæ.—A communication was read from Mr. R. Swinhoe containing an account of a new Cervine form discovered in the mountains near Ningpo, China, by Mr. A. Michie, and proposed to be called *Lophotragus michianus*.—Dr. J. Murie read a paper on the structure of the skeleton of *Fregilupus varius*, based on a specimen in the Museum of Cambridge.

Meteorological Society, June 17.—Dr. R. J. Mann, president, in the chair.—On the connection between colliery explosions and weather in the year 1872, by Robert H. Scott, F.R.S., and W. Galloway, Inspector of Mines. The paper is in continuation of those by the same authors read before the Royal Society in 1872, and before the Meteorological Society in 1873, which contained the results for the four preceding years. The number of fatal explosions which occurred during the year was 70, causing the loss of 163 lives. Three of these killed each of them more than ten men, being the same as the average number of serious explosions for the last twenty years. The number of non-fatal explosions was 224. A comparison of the dates of all recorded explosions with the curves of the barometer and thermometer kept at Stonyhurst for the Meteorological Office, as shown on a diagram, lead to the following results: 58 per cent. of the explosions are due to changes of pressure, 17 per cent. to great heat of the weather, while 25 per cent. are not attributed by the authors to meteorological agencies. These proportions are nearly the same as those which have come out from the discussions of similar facts for previous years. The paper next deals with an objection which has been raised to the reasoning in its predecessors, viz. that it is not fair to take the meteorological records for Stonyhurst as a test of the atmospherical phenomena in a coalfield situated at some distance from the observatory. The authors show, by taking an instance of a barometrical depression, whose centre passed over Stonyhurst, and which was accompanied by an explosion in South Wales, that such an objection as that cited could never have originated with anyone accustomed to deal with daily weather charts. The next question discussed was the alleged greater prevalence of explosions with certain winds; and it was shown by the most reliable data for our climate that the ordinary changes of pressure and temperature in the windrose were hardly sufficient to account for the explosions which are found to accompany the *sudden* changes of weather. The paper proceeds with a discussion of a diagram exhibiting the continuous curve of barometrical pressure from Glasgow Observatory for the last nine months of 1873, and a curve showing the prevalence of fire-damp in the mines of the West of Scotland district for the period. These latter returns have been furnished by Mr. Galloway from the entries in the books ordered to be kept at each mine by the Coal Mine Regulation Act, 1872. The books of thirty-five mines about Glasgow have been used for the comparison. The two curves show a very remarkable accordance in their course, though that of fire-damp exhibits some striking irregularities, owing probably to the fact of the men having been slow to learn the new duties required of them by the Act. It may be expected that these irregularities will disappear in future years. The result places it beyond the possibility of a doubt that the escape of fire-damp is related mainly to the conditions of atmospherical pressure, and that a careful watch over the barometer is, above all, necessary in each colliery, though one such record would suffice for several adjacent mines. The paper gives some instances of explosions which might all have been prevented by proper ventilation and by the use of safety-lamps, and states how pressing the need is that safety-lamps only should be used in all places where fire-damp may accumulate, whenever the atmosphere is in a disturbed condition, as shown by the record of the barometer and thermometer. The authors conclude by stating their conviction that it is not too much to ask those charged with the responsibility of the safety of miners' lives to learn the first principles of the laws of diffusion and intermixture of gases, and to familiarise themselves with the use of the barometer and thermometer, so as to know when it behoves them to take extra precautions in the management of their mines. —Solar radiation, 1869-74, by Rev. F. W. Stow.—The diurnal inequalities of the barometer and thermometer, as illustrated by the synchronous observations made during May 1872 at the summit and base of Mount Washington, New Hampshire, at the respective heights of 2,615 ft. and 6,283 ft. above the sea-level, by W W Rundell. The hourly mean differences of pressure and temperature at these stations and at Portland, Maine, the nearest U.S. station to Mount Washington, are discussed and their most probable coefficients are determined, also the times at which their maxima and minima occur.—On the diurnal variation of the barometer at Zi-Ka-Wei, and mean atmospheric pressure and temperature at Shanghai, by Rev. A. M. Colombel. —Weather report for 1873 at Woosung, China, by C. D. Braysher.—Notes regarding a remarkable hailstorm at Pietermaritzburg, Natal, on April 17, 1874, by Rev. J. D. La Touche.

Royal Astronomical Society, June 12.—Prof. Adams, president, in the chair. A paper by Mr. Stone, the Government astronomer at the Cape of Good Hope, was read, describing his observations of the eclipse of April 16 made near Klipfontein, in South Africa, of which an account has been given in NATURE (vol x. p. 59). Mr. Bidder described a micrometer which he had contrived for measuring the position of very faint stars. Ghosts of the wires, which can be rendered dimmer or brighter at the discretion of the observer, are projected into the field of view by means of reflecting prisms; and diaphragms can be used, cutting out the light of the wires from any portion of the field. M. d'Abbadie was called upon to give some account of the French preparations for the transit of Venus. The French Government will occupy five stations and will make use of the Daguerreotype in preference to the collodion process. Their photographs will be taken in the principal focus of their instruments, and the image of the sun will thus be only about 36 millimetres in diameter. The trial photographs are so sharp that they hope to be able to make use of a magnifying power of 250 in measuring the photographs for the purposes of reduction.—The President announced to the Society that a petition was about to be presented to the Dean of Westminster, praying him to admit of the erection of some memorial to Jeremiah Horrox in Westminster Abbey.—It was announced that the next meeting of the Society would be held in their new room in Burlington House.

PARIS

Academy of Sciences, June 15.—M. Bertrand in the chair.—The following papers were read:—Solar theories; reply to some recent criticisms, by M. Faye. The author meets objections raised by MM. Ledieu, Duponchel, and P. Secchi, in former numbers of the *Comptes Rendus*.—On the heat evolved by chemical reactions in the different states of bodies, by M. Berthelot. The author considered the heat developed in the gaseous, liquid, and solid states.—Observations on the communication relating to Phylloxera made by M. Lichtenstein during the *séance* of June 8.—A note by M. Blanchard, in which the author highly eulogises the experiments of Lichtenstein.—Researches on the electrolysis of the alkaline carbonates and bicarbonates, by MM. P A. Favre and F. Roche. This is a thermo-chemical research undertaken with a view of throwing light on the constitution of these bodies.—On the phenomena of static induction produced by means of Rhumkorff's coil; a note by M. E. Bichat. The author finds that static electricity, as from the Holtz machine, when passed through the secondary wire gives rise in the primary wire to the development of a current possessing all the properties of the voltaic current, and like this current appearing to have only one direction.—M. J. M. Gaugain presented a note on magnetism.—On some properties of the systems of curves ($\mu = 1, \nu = 1$), by M. Fouret.—Generalisation of a theorem communicated at the *séance* of June 1, by M. H. Durrande.—On oxyfluoboric acid, by M. A. Basarow. This acid is stated to be produced when boric fluoride is passed into water, and the assigned formula is $BO_2H, 3HF$. The present research tends to prove that no such body exists, the composition formerly determined by analysis being a result of chance.—On the absorption of ammonia from the air by vegetables, by M. T. Schlœsing. The author has been growing two tobacco plants under precisely the same conditions, except that one plant was freely supplied with ammonia, while the other was excluded from this gas. Analyses prove that the plant supplied with ammonia is much richer in nitrogeneous compounds than the other.—Research on the oxygen dissolved in the water of artesian wells, by M. A. Gérardin. The author concludes that oxygen is never found in subterranean waters if these are kept out of contact with the air. —On a case of lead-poisoning, by MM. G. Bergeron, and L. l'Hote.—On creatine, by M. R. Engel. The author has studied the reactions of this substance.—Anæsthesia by intravenous injection of chloral after the method of Prof. Oré; removal of a cancer from the rectum, by MM. Deneffe and Van Wetter.—On the geology of the regions comprised between Tangiers, El-Araich et Meknès (Morocco), by M. Bleicher. The author has recognised the following formations—recent, tertiary, cretaceous, and jurassic.—On the character of the littoral zone in the English Channel, the ocean, and the Mediterranean, by M. P. Fischer.

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