THURSDAY, AUGUST 9, 1877

ELECTRICITY IN WAR

THE important *rôle* played by electricity in modern warfare affords an excellent example of the influence which science has of late exerted in naval and military affairs. It is no isolated example of scientific warfare that we have here to deal with, for the electric fluid has in a great measure changed our whole practice of war, and bids fair to revolutionise it still more in the future. Every soldier or sailor, if he desires to make his mark, must be something of an electrician, for there seems to be no limit to the useful applications of the galvanic spark in battle. Broadly, we may divide these applications under three heads; namely, the employment of electricity for signalling, for the explosion of charges, and lastly, for illumination, both for the purposes of attack or defence, it being a difficult matter to decide in which connection the electric spark fulfils the most important duty.

To begin with the telegraph. All will agree that it is well-nigh impossible to overrate the advantages which this rapid means of communication gives to the general, in these days, when the line of battle sometimes extends for a dozen miles. Let the commander occupy the most central position, a long time must elapse before his aides-de-camp can communicate with one wing or the other. Assisted by the electric telegraph, however, the general is as close to his subordinates as if he were within shouting distance. Even a brigade of horse artillery, or a cavalry division advancing at a gallop, can carry its telegraph equipment with it, the operators accompanying a flying column of this nature with but very little difficulty. The wire drums are started off at a gallop, the cable being unwound as the carts proceed, and a sergeant on horseback with a "sounder" to his ear, in connection with one end of the wire, receives the general's commands as soon almost as they are spoken. The movement countermanded or a retreat ordered, the cable is again wound up as readily as it was laid down, and the telegraphers make good their return with the rest of the troops. Where ordinary movements are executed, use is of course made of the telegraph wagon, a comfortable little office on wheels, furnished with all things necessary for the receipt and despatch of messages, but this convenience is naturally out of place where a rapid change of front, or some speedy flank movement has to be executed.

Coming next to the explosion of charges by means of the electric spark, we enter upon a phase of war-science which bids fair to grow to infinite proportions. Both Franklin and Priestley suggested the employment of electricity in this connection more than a hundred years ago, but it is very recently indeed that we have been in a position to make proper use of this valuable agent as a means of firing charges at a distance. In fact, at the present moment we have by no means exhausted research in this direction, and we find scientific soldiers and sailors still at variance with one another as to the best plan of using the electric current for firing purposes. One of the first applications made of the subtle fluid was in the removal of the wreck of the *Royal George*, at Spithead, nearly fifty years ago, when the explosion of the charges was brought about by what is termed a wire-fuse, or in other words a short piece of platinum thread stretched between two copper wires. The platinum bridge having less conducting power than the copper wires, presents a considerable amount of resistance to any current of electricity that passes, and, in doing this, becomes so heated, as to be capable of igniting any particles of gunpowder in contact with it. A wire-fuse of this description has simply to be placed in the middle of a charge, and if then a current of electricity is passed from a battery along the wire in connection with the fuse, instantaneous ignition is the result. This simple method of firing charges under water was a vast improvement over the old one in use by our engineers, which consisted in leading up a metal pipe from the charge to the surface of the water; the outlet of the pipe was placed as far as possible from the charge beneath the water, and then a ladle full of red hot shot was emptied down it, and so reached the gunpowder below, which thereupon exploded if the iron fragments had not become too cool in transit.

But for many purposes the wire-fuse is ill-adapted to the military and naval services. A voltaic battery is necessary to evolve the low-tension electricity required to yield sufficient resistance and heat, and such a battery made up of metal plates, and involving the use of acids, is an awkward apparatus to carry in the field. Already in 1853, this fact seems to have occurred to a Spanish officer, Col. Verdu, who determined to see what could be done in the way of exploding gunpowder by a spark, or in other words, by high tension electricity. Aided by a Ruhmkorff coil he succeeded in firing half-a-dozen charges simultaneously, and although the discharge was sometimes a matter of considerable uncertainty, to Verdu certainly belongs the credit of having been the first soldier to apply electricity in this way to the firing of one or more mines. Wheatstone and Abel followed in Verdu's footsteps, and while the former directed his attention to the construction of a frictional apparatus of a portable nature, which should be suitable for military use, the latter busied himself in the preparation of a fuse inclosing a compound more delicately explosive than gunpowder, a fuse, by the way, which still retains an important place among our warlike stores.

It was in the China war of 1860 that we first find an electric firing apparatus forming part of an army equipment. In this case the outfit was of a somewhat clumsy nature. A conveyance, in shape and size much resembling a baker's barrow, contained a monster horse-shoe magnet, and it was the sudden disruption of its armature from this magnet which generated the spark to fire the fuse. A few years afterwards, this ponderous conveyance gave place to a neat little mahogany box about a foot cube, which contained half a dozen small but powerful magnets, in the field of which the armatures were made to revolve with exceeding celerity; and it is by means of such an apparatus that to day we are enabled to fire a score of charges at a time, the wires branching off from the instrument to a distance of a hundred yards or more. But, nevertheless, we have yet to devise, it seems, an efficient exploding apparatus capable of igniting both low and high tension electric fuses.

As everybody knows, it is by reason of electricity being employed to fire explosive charges that torpedo warfare has of late attained to so important a position. In the Whitehead, or fish-torpedo, the electric fluid, it is true, plays no part, but this is the only notable exception. In the floating torpedo, the moored torpedo, and the spar-torpedo, electricity is the life and soul; at one moment the machine is but a floating buoy or sunken impediment, the next it is transformed into a terrible volcano. A feeble current of electricity flashing along the wire, has on the instant sufficed to bring about the fatal change.

Passing from torpedo warfare and the recent attempts that have been made to turn electricity to account in the construction of self-steering launches, we come to a scarcely less important matter, that of firing guns by the electric spark. Not only are guns at proof and those under experiment so ignited, but on board the modern ironclad it is the custom now-a-days to fire broadsides in this wise also. By leading wires from every gun to one point, which is specially adapted for observation, the double advantage is secured of bringing about the firing at the most opportune moment, and of securing a simultaneous discharge. Some experiments made in Germany have proved beyond doubt that an armour plate struck instantaneously in this way by several shot, may be effectively broken up, whereas the ordinary broadside fire, brought about by gunners at word of command is incapable of doing so. The wires may be led into an observing tower, or half way up the mainmast if need be, and here the firing officer can calmly consort his measures undisturbed by the smoke, and noise, and bustle going on below him. He is provided with proper sights, and the guns being laid in accordance with his orders, he can watch the opportunity for firing as well as if he had his eye to the weapons themselves.

Finally, we have the use of the electric light in warfare. It is the most recent application of all of this wonderful agent, and we should hesitate to say how extensive may hereafter be the employment of electricity in this connection. In the Franco-German war, the first use of this powerful source of illumination was made by the French engineers, and from the forts around Paris the electric rays were made to sweep in all directions, to watch for hostile troops engaged in the operation of mining. Bodies of soldiers upwards of a mile distant could be plainly seen by the vivid light of the electric lamp, and working parties were frequently compelled to abandon their object in the presence of this powerful detector. As a means of discovering the approach of torpedo launches at night, the electric light will obviously be of value, and already a trial of it has been made in several of Her Majesty's ships. The *Alexandra*, the flagship of the Mediterranean fleet, is provided with an electric lamp, worked by one of Wilde's powerful machines, so that the efficiency of the apparatus may be practically tested. Experiments, however, have already shown what the electric rays are capable of doing, and a low torpedo-launch cannot approach within a thousand yards without detection, while if painted of a neutral grey, so as the better to escape observation by day, the vessel, it appears, is all the more perceptible under electric illumination. Steamers, we are told, are peculiarly liable to be detected by an electric lamp, since the rays are reflected by the steam and smoke as effectively as if the latter were a solid screen. How valuable, too, the electric light on board ship must prove for signalling purposes may be gathered from the fact that the Dungeness light, which was the first one of an electric nature constructed in this country, can be seen on a clear night at a distance of thirty miles with all the brilliancy of a star of the first magnitude.

H. BADEN PRITCHARD

THE GEOLOGY OF THE VIENNA WATER SUPPLY

Geologie der Kaiser Franz-Josefs Hochquellen-Wasserleitung. Eine Studie in den Tertiär-Bildungen am Westrande des Alpinen Theiles der Niederung von Wien. By Felix Karrer. (K.K. geolog. Reichsanstalt. Vienna, 1877.)

THE publications of the Austrian Geological Institute are deservedly noted for their number, their fulness, and the beauty of their illustrations. Especially are the large quarto memoirs published under the name of *Abhandlungen* remarkable in the latter respects. Consisting usually of complete monographs, sometimes purely palæontological, but more often blending stratigraphy with palæontology in a manner which is too seldom resorted to in this country, these handsome volumes are quite independent of, whilst they frequently illustrate, the maps issued by the same authority.

The present work forms vol. ix. of this important series. In many ways it is unlike its forerunners, but it resembles them in its completeness and in the finished character of its plates. Although eminently local in interest yet so many points are touched upon—or rather fully discussed—in Dr. Karrer's memoir that it appeals to the civil engineer, the hydrologist, the archæologist, and the chemist in almost as great a degree as to the geologist and the systematic palæontologist.

This great closely-printed book of more than four hundred pages, with its numerous tables and large folding plates, is strictly what its title implies, viz., an account of the geology exposed by the engineering works recently carried out in order to bring the waters of the Kaiserbrunnen and Stixtenstein springs to Vienna, a distance of some twelve Austrian or fifty-five English miles.

All the leading features of this section could probably have been described and commented on with apparent fulness in a short paper in the *Verhandlungen* of the Institute, but the aim of the author has been to raise the character of his memoir from that of a passing pamphlet to that of a thoroughly exhaustive record of all the facts—the seemingly unimportant as well as the obviously valuable—which could be brought within the natural limits of his subject. In this object he has perfectly succeeded, and the result is an orderly collection of minute stratigraphical and other details such as, we believe, have never before been brought together with reference to so small an area.

From Kaiserbrunnen at the foot of the Schneeberg and from Stixtenstein a little further north to the very streets of the Capital, or, geologically speaking, from the triassic heights of the Noric Alps to the drift and alluvium overlying the Tertiary beds of this Alpine portion of the Vienna Basin, only those valleys across which the aqueduct replaced the cutting and the tunnel were left unsearched and unplotted by Dr. Karrer. Every bed, band, thinning, thickening, fault, slip, or flexure cut through by the artificial channel was measured and noted by him, and all these details are laid down on a true scale (except in one unavoidable instance) in twelve carefully drawn and coloured plates of sections. So far, however laborious, the work done may be said to be more or less mechanical. This is not the case with regard to the clear sketch-sections or outline views which accompany the measured lines. In these we have exhibited to us the relations in which the rocks seen in the cuttings stand to those of the surrounding country, and we perceive at once the eye and hand of the field-geologist.

Since 1859 Dr. Felix Karrer's name has been constantly before the scientific world as that of an active member of Ritter von Hauer's brilliant geological staff. His researches have lain principally among the beds of the Vienna Basin and their fauna. In conjunction with Theodor Fuchs his papers on these and allied subjects have been both numerous and valuable; but more particularly has Dr. Karrer devoted himself to the study of the Foraminifera which these deposits yield in such abundance, and now it may be said that he fitly succeeds to the honourable place so long held by the late Dr. A. E. von Reuss as one of the leading Rhizopodists in Central Europe. Accordingly we find in the present work elaborate tabular lists of the Foraminifera found in the borings and elsewhere in the course of the engineering operations, and no less than seventy-one forms figured and described as new. With reference to these it will be sufficient to observe that many of them are such as, according to the views prevalent in England, would be scarcely held to warrant specific distinction.

The Alpine Vienna Basin, the margin of which between Gloggnitz and Vienna is the region where the geology has been specially worked out, was, it seems, dry land at the time when the Older Mediterranean Sea covered the Basin beyond the Alps. Consequently the Younger Mediterranean Series, its marine sands and gravels passing into grits and conglomerates with intercalated bands of Nullipore limestone and marls, are the lowest of the Tertiary deposits present here. To this series belongs the famous "Leythakalk," about which so much has been written. The fauna of these beds is closely allied to that of the Adriatic of the present day, whilst some of its species denote a somewhat warmer sea. Upon these newer Mediterranean strata rest the Sarmatian beds, in three divisions, the fossils of which allow us to infer a great cooling of the sea accompanied by an invasion of Asiatic cold-sea forms. This was followed by a period of brackish and then of fresh water, which brings us to the well-known Congeria beds, above which only two more members of the Tertiaries occur, viz.: the Belvedere beds and the purely local but highly-interesting freshwater limestone of Eichkogel, near Mödling, which formed the subject of Dr. Karrer's first contribution to science.

It will be readily understood that the works entailed by the construction of the watercourse promised unequalled opportunities for studying in detail the shore facies of these various deposits, and comparing them with the aspects they exhibit in other parts of the basin. That these opportunities have not been lost this memoir affords abundant proof.

From Stixtenstein and Kaiserbrunnen to Ternitz, where the two head-channels meet to form a single watercourse, the rocks cut through are of much greater age. Here we have carefully described by Dr. Karrer, although he does not profess to do so as minutely as his more congenial tertiaries, micaschist and *grauwacke* of uncertain age, and, in disturbed order, the Wetterstein, Guttenstein, and Werfen divisions of the Alpine trias. At Baden and again at Mödling, short spurs running like headlands into the ancient Viennese sea, once more bring the uppermost of these formations (the Wettersteinkalk) within the line of section.

At the former of the two last-mentioned places is a group of well-known thermal springs ranging from ordinary temperatures to 95° F. Several pages of considerable interest are taken up by the discussion by Prof. Eduard Suess of a large series of observations relative to these springs carried on by Prof. Jellinek. Their topographical distribution is peculiar and is strikingly shown on a map (Plate xiii.) by means of isothermal lines, the intervals being of 1° Réaumur from 8° to 13°, then one of 3° from 13° to 16°, and lastly, one from 16° to 28°: that is to say, the spaces between the lines of the first series represent 1° each, then 3°, and lastly 12° Réaumur. This mode of dealing with thermal phenomena by means of contour-lines is new to us and seems fruitful of good results. In the present instance five distinct foci of greatest heat are well made out, with several outlying ones attaining lesser degrees of temperature.

The chemical composition not only of the hot springs, but also of the various waters referred to throughout the book, is given in numerous analyses by chemists of note.

The line of the watercourse runs more or less parallel to the Southern Railway. In 1840, when the latter was in course of construction, several discoveries of prehistoric implements were made at Potschach, and elsewhere. It is therefore not surprising that the new excavations should have given rise to similar finds. Of these the most important appears to be an old burial-ground of the bronze age at Leobersdorf, a little to the south of Baden. Here bronze rings, daggers, armlets, &c., were found associated with fairly-preserved human remains. The former are described by Baron von Sacken, the Director of the Imperial Collection of Antiquities, whilst full details respecting the latter are furnished in an anthropological chapter by Friedrich Steller. Both are well illustrated by coloured plates and woodcuts.

The question may perhaps be reasonably asked, why so much labour and money have been expended on the particular subject chosen. But when we remember the losses that British geology has sustained by the neglect of so many invaluable sections temporarily exposed in the early canal and railway days and now covered up and lost for ever, we may well regret that no devoted geologist was there to preserve the minute records of the rocks and their disturbances in as accurate and painstaking a manner as Dr. Karrer has done in the case of the Austrian Watercourse. Given the opportunity of issuing a report on so complete a scale—an opportunity which we fear will never occur in England—no objection can be made to his mode of setting forth his results. A more condensed account would have been more readable, and probably more acceptable to foreign geologists, but among the local investigators in the district to the south of Vienna, which the author delights in calling that "*stückchen Erdrinde*," the book must at once take rank as a storehouse of actual facts never to be over appreciated.

The value of the memoir is much enhanced by the long bibliographical list with which Dr. Karrer opens the work, and which is brought up to date in the appendix. This list contains the titles of 566 books and papers relating to the region traversed by the *Aqueduct*, and arranged, as all such lists should be, in chronological order. The first paper cited is one by Wolfgang Anemarinus, on the Baden springs, and dates as far back as 1511.

From what we have said it will be seen that no labour has been spared to render this report as perfect as it could be made. One serious omission, however, must be called attention to. There is no index. The late Sir Roderick Murchison was wont to deplore that many of the details contained in his "big books" remained unknown and buried within them. But books like the "Silurian System" are certain to be consulted, index or no index. To publish a work so local in character, albeit so complete in its execution as the one under review, as Dr. Karrer has done, without a key to the endless facts it contains, is deliberately to court non-recognition.

Before concluding we would note the excellent geological map of Vienna and its immediate neighbourhood, by Th. Fuchs. This map was first issued in 1874, and is conveniently reproduced in the present memoir.

G. A. LEBOUR

A CENTURY OF DISCOVERY

The Discoveries of Prince Henry the Navigator, and their Results; being the Narrative of the Discovery by Sea, within One Century, of more than Half the World. By Richard Henry Major, F.S.A. Portraits, Maps, &c. (London: Sampson Low and Co., 1877.)

Geschichte des Zeitalters der Entdeckungen. Von Oscar Peschel. Zweite Auflage. (Stuttgart: J. G. Cotta, 1877.)

THESE two works practically refer to the same period, which nearly coincides with the fifteenth century, and deal mainly with the same events. Mr. Major's work centres round Prince Henry as the initiator of the remarkable series of discoveries which were made during the century referred to, while that of the late Oscar Peschel deals with these events as forming a remarkable era in geographical discovery, and is considerably more detailed than the work of Mr. Major. Both works are virtually second editions. In its present form Mr. Major's is somewhat more popular than when first published, the discussion of certain points interesting only to the student having been omitted; Peschel's work, first published about twenty years ago, is practically unaltered. Both works are valuable contributions to the history of one of the most eventful centuries of our era; Mr. Major's is a worthy record of the life and work of a noble-minded prince, while Peschel's is a standard authority on the geographical work of the fifteenth century.

Prince Henry, aptly styled "the Navigator," was the fifth child of King João I., of Portugal, and his Queen Philippa, daughter of "old John of Gaunt, time-honoured Lancaster," and was born in 1394. He was carefully trained by his English mother, and after having distinguished himself at Ceuta, took up his abode on the promontory of Sagres in Algarve, of which kingdom he was made governor in perpetuity. It was from here that during the rest of his life he initiated and directed those discoveries with which his name will be ever associated; to Prince Henry, there is no doubt, the rapid progress of geographical exploration during the fifteenth and sixteenth centuries is mainly due. But not only in this way did he encourage the advance of knowledge; by providing professorships, and in other ways, he did much to foster the progress of science such as it was in his time; his own favourite subjects of study were astronomy and mathematics.

It is with Africa that Prince Henry's name is chiefly associated. Before commencing his great work of exploration he took every means in his power of ascertaining all that was known about Africa, though that was not much. Cape Blanco he knew, though vaguely, but all the coast south of that was practically a blank. The interior was known much farther southwards, and not a few details of Timbuctoo had reached Europe by the beginning of the fourteenth century. It does not seem to be known whether Prince Henry had the means of making himself acquainted with the work done by the Phœnicians and Carthaginians; the narrative of Hanno's famous coasting voyage would have been a treasure to him, but the likelihood is that he was totally ignorant of the work accomplished by these pre-Christian explorers. Nor is it likely that he had heard of the Norse discovery of America, though he may have heard of the famous voyages of the brothers Zeni; if he had it does not seem to have suggested to him the existence of a great continent far beyond the horizon which bounded his outlook from Sagres. Prince Henry set about the work of African exploration with intelligence, his clear object apparently having been to trace the African coast to its southernmost limit, and even discover by rounding it a practical sea-route to India.

"Very few details are left us," Mr. Major writes, "of the astronomical instruments used in the time of Prince Henry. The altitude of a star was taken by the astrolabe and the quadrant by means of an alidade, or ruled index, having two holes pierced in its extremities, through which the ray passed. The quadrant hung vertically from a ring which was held in the hand. We do not know how these instruments were graduated, but it is to be presumed very roughly. The astrolabe, the compass, timepieces, and charts, were employed by sailors in the Mediterranean at the beginning of the fifteenth century. It is quite certain that the needle was used at sea before Prince Henry's time, for he himself speaks of it when urging on one of his navigators to the rounding of Cape Bojader." During the lifetime of Prince Henry the African voyagers stuck closely to the coast, except when by accident they were driven from it.

The Prince's enthusiasm and generosity drew to him most of the adventurous spirits of his time, and thus it was that after his settlement on Sagres scarcely a year passed that he did not send out one or more expeditions to carry on the great work which he had set himself to accomplish. The first fruit of Prince Henry's enterprise was the finding of the islands of Porto Santo and Madeira, in 1418–20, by two squires of his own household, who were driven thither by a storm off Cape St. Vincent. Mr. Major has, however, proved satisfactorily, we think, that the Madeira group were discovered about the end of the previous century by an adventurous Englishman named Robert Machin.

For long had Cape Bojader proved an obstacle which the Portuguese sailors sent out by the Prince attempted in vain to pass; Cap Nun had been passed, but the increasing violence of the waves that broke upon the dangerous northern bank of Cape Bojader proved too much for the cockle-shells in which Prince Henry's explorers were hardy enough to risk their lives. It was only in 1434 that Gil Eannes, a native of Lagos, managed to pass this fancied terrible obstacle to progress, by putting well out to sea. Next year another fifty leagues were added to the stretch of coast discovered, and thus year after year, league upon league was added, and specimens of the people and products brought home, the former to be Christianised and sent back to convert their brethren. By the time of Prince Henry's death in 1460, the west coast of Africa had been explored under his auspices as far south as the Rio Grande, the Canaries, Cape Verde Islands, and Madeira discovered or rediscovered, and a large amount of substantial information obtained about the people, the products, and the country far into the interior of Northern Africa.

Mr. Major justly designates Prince Henry the originator of continuous modern discovery, for Portuguese enterprise in this direction was not stopped by his death. It was not, however, till 1471 that the equinoctial line was crossed for the first time within the memory of man, probably by an explorer named Lopo Gonsalvez. The equator was not much surpassed till Diego Cam set out in 1484 and discovered the mouth of the Congo; the celebrated Martin Behaim, the inventor of the application of the astrolabe to navigation, was with Diego Cam in this eventful voyage. In his next voyage Diego got as far south as Cape Cross in 22° south latitude, where the cross he planted is still to be seen in almost complete preservation. In 1486 Bartholomew Diaz was sent out by King João, of Portugal, to carry out the discovery of the African coast, and, without knowing it, passed the southernmost part of Africa and came to anchor in what is now known as Flesh Bay, near Guaritz river, to the east of Cape Agulhas. He turned back after reaching the mouth of the Great Fish river, and it was on this return voyage that he discovered what he called Cape Tormentoso, but which King João on his return, "foreseeing the realisation of the long-coveted passage to India," named Cape of Good Hope. It was not till ten years after this that a practical test was made of the utility of this passage to India. Vasco da Gama left Lisbon with four vessels, the largest not exceeding 120 tons, in July, 1497, and coasted south the west coast, and north the east coast of Africa, as far as Melinda, to the north of Mombassa, which was reached in April of the following year. On April 20, 1498, he sailed for Calicut, before which he anchored on May 20, thus discovering the famous "Cape route" to India.

Such are a few of the results which are directly or indirectly due to the far-seeing enterprise and noble-mindedness of Prince Henry the navigator. But these are not all. But for his initiative in the beginning of the century, it is doubtful if America would have been discovered at the end of it, and had Prince Henry been alive when Columbus began his memorable agitation, that greatest of explorers would doubtless have been saved much humiliation and misery. Magellan's circumnavigations fall also within this most eventful of eras, and not far beyond it, Mr. Major has proved, the discovery of Australia. "The coasts of Africa visited, the Cape of Good Hope rounded, the New World disclosed, the sea-way to India, the Moluccas, and China laid open, the globe circumnavigated, and Australia discovered within one century of continuous and connected exploration," begun and to a great extent carried out by the prince the story of whose life Mr. Major has told so well. We can only again commend his work and that of Peschel to our readers as not only full of interest but of much valuable information.

OUR BOOK SHELF

Chemical Handicraft. A Classified and Descriptive Catalogue of Chemical Apparatus suitable for the performance of Class Experiments, Research, and Chemical Testing. Second Edition. By J. J. Griffin, F.C.S. (Published by the Author, Garrick Street.)

MR. GRIFFIN, the well-known manufacturer of scientific apparatus, earned the thanks of all students of science in this country by the publication of his first catalogue, now some eleven years ago, when the condition of things was much less far advanced than it is now. He has earned still greater thanks for his last edition, which is much more complete, more copiously illustrated, and more carefully brought up to the present needs of the student and the present possibilities of the maker. Those who noticed the many collections of such apparatus at South Kensington, last year, among which was one sent in by the Messrs. Griffin, cannot have failed to have been struck by the complication of the apparatus now required for chemical researches, and the skill, both in glass and brass, required to produce them. Mr. Griffin is evidently doing his best to uphold English manufactures against his continental rivals, and we wish him and his book every success. As the madman said of the dictionary, it is not light reading, and the plot is feeble; but, nevertheless, the book will be of use in every laboratory.

LETTERS TO THE EDITOR

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

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

The Cretaceous Flora of America

I AM extremely obliged to Dr. Newberry for pointing out in a very kind manner what is the actual state of our knowledge at the present time respecting the American cretaceous beds. Never having travelled in America, nor having had the honour of conversing with any of the American *savants* who have investigated the remains in these beds, I am scarcely in a position to discuss with them the value of the evidence on which they have been considered cretaceous. I have, however, endeavoured to make myself acquainted with the literature of the subject, and had read most of the works mentioned by Prof. Newberry in his letter to NATURE. I in no way dispute that dicotyledonous leaves have or may be found in cretaceous strata, but have, on the contrary, endeavoured partially to account for their absence in British cretaceous rocks. The age of the supposed American cretaceous beds appear to me, however, to be determined principally from the presence of Ammonites, Hamites, and other dibranchiate cephalopoda, and other types of mollusca as Inoceramus. Now what I intended to imply was that the presence of these is not conclusive evidence that the beds in question are as old as our chalk. Between our chalk and the base of our eocene a great hiatus exists, during which almost the whole of the cretaceous fauna became extinct, at least in European seas. This extinction and complete change of fauna implies an immense interval of time which, although we have but little record of it in Europe, we may expect to find recorded elsewhere.

It is at least possible that the series in question in America may be this record. In the lower, as in the Dakota group, we have, mixed with many decidedly (as we have been wont to consider them) cretaceous types of cephalopods, gastropods and bivalves of an eocene aspect. No comparative tables of fossils nor determinations of any value of European species from these beds have been made. But assuming that a portion of the lowermost cretaceous rocks of America were synchronous with some of our upper European cretaceous rocks, we may still suppose the mass of the strata to be of younger age. As very fairly stated by Dr. Newberry, Mr. Lesquereux does not agree with him as to where the division between cretaceous and eocene in the lignitic beds should be placed. Hayden[1] says that the age of the lignite strata is obscure. "The evidence points at the present time to the conclusion that the lower portions of this group are cretaceous, passing up by gradual transition into the tertiary, and that the greater portion may be regarded as of the age of the later period." Cope and Marsh, again, from the presence of Mososaurus, considered the lignites to be cretaceous. It seems to me that as the lignitic flora has the same character throughout its entire thickness, the formation must be considered as a whole, and that instead of endeavouring to correlate portions with either the European chalk or eocene, it would be simpler for American geologists, and more in accordance with the evidence we possess, to recognise the fact that the American series more or less represents the great hiatus existing in Europe between these formations. Although the upper portion of the lignites, the total thickness of which has been estimated at 10,000 feet, may be contemporaneous with a part of our eocene, the absence of any of the types of eocene flora, such as are characteristic at Sezanne, Bournemouth, &c., is opposed to the supposition, as much as the absence of anything at all approaching the Dakota flora in our cretaceous rocks is opposed to the contemporaneity of the latter.

These series may still, however, be conveniently spoken of relatively, and for the purposes of American geology, as cretaceous, but not until further evidence is adduced can they be recognised as synchronous with any portion of ours.

J. S. GARDNER

[1] "Geological Survey of Territories," 1872.

Automatism

MR. SPALDING in his able review of "The Physical Basis of Mind," alludes to the term automatism, about which there has been so much controversy. The word, however, is a most unsuitable one for designating the important doctrine inculcated so clearly by Mr. Spalding, as well as by Huxley and Clifford. The ordinary meaning of "automaton" is a machine whose actions are unattended by feeling. Now as the most striking difference between an organic machine and an inorganic one is that the movements of the living machine are accompanied by sensations, while those of the inorganic machine or automaton are without concomitant sensations, it is plainly a mistake to apply to the actions of the sentient machine a term which has as a fundamental part of its meaning the absence of sentience. The incongruity is so manifest that I think it not improbable that it is one of the sources of the facile confidence displayed by some of the opponents of "automatism"; and if the word were supplanted by a less objectionable one, it is possible that the important doctrine intended to be designated by it might be accepted with less difficulty. I would suggest that some word meaning concomitant action or synchronous procedure might be coined for the purpose. The Germans, who are so fond of long, amalgamated expressions, would perhaps use something like "associated—mutually inconvertible—processes" to designate this dual unity of the subjective and objective sides of mental action.

D. SHARP

Thornhill, Aug. 5

Local Museums

IN common with Mr. Allen, and doubtless very many others, I have read the articles and letters on Local Museums with a great deal of pleasure; and I am very glad that Mr. Allen has made his practical suggestion. In February last, in a paper which I read before the Hastings Philosophical Society on "Local Museums and Libraries of Reference," I made a similar suggestion for our own locality. You may think the matter of sufficient importance to justify the insertion of the following few lines from my paper:—

"I do not wish to put such institutions as I am advocating into competition with things of a very different character; but I would ask whether a zeal somewhat akin to that which is exhibited in raising funds for religious societies ought not to be exhibited on behalf of such purposes as those under discussion? Would it be at all absurd to talk about having a *mission* to establish a public library? . . . For my own part I can conceive of few nobler aims than that of raising for one's town a permanent public institution of an intellectual character. If a committee were to take up the work with enthusiasm and were able, even though after many years of toil, to say to the people of Hastings: 'We have built for you, with your own help, a library and museum, and we have, with funds with which the public have supplied us, sufficiently endowed this institution to carry on all its legitimate work, and we now hand it over to you, the people of the town of Hastings, as the property of you and your children for ever'—I say a committee that took in hand and accomplished such a work would deserve the deepest gratitude of the borough, and would have a right to claim to have accomplished a *mission* of no small importance."

A. R.

Hastings, August 3

July Shooting Stars

I OBSERVED 197 shooting-stars in July—nearly all of them between the 6th and 20th—in twenty-four hours of watching. The weather was generally very cloudy and stormy between the 13th and 23rd, or many more would have been seen. I looked usually towards the eastern sky, and from the considerable number of meteor paths registered, am enabled to give the following table of radiant points visible in that quarter during the period of my observations. The list may be considered very fairly complete and accurate, for the great majority of the meteors were well seen, and many of them had short courses evidently near their radiant centres:—

Radiant Point.			
Approx. Star.	R.A. °	Dec.	No. of Meteors.
ρ Cassiopeiæ	349	+ 53	8
β Aquarii	317	− 11	13
χ Aquarii	336	− 7	5
ι Pegasi	333	+ 26	8
ζ Pegasi	338	+ 11	11
f Lacertæ	334	+ 43	7
σ Andromedæ	4	+ 35	21
θ Persei	36	+ 47	6
ε Cygni	313	+ 33	6
α Cygni	315	+ 48	8
ζ Cassiopeiæ	6	+ 53	11
δ Cygni	290	+ 43	9
α β Persei	47	+ 45	5
θ Antinöi	298	− 8	5
δ Ursæ Minoris	295	+ 85	6
π Herculis	258	+ 37	6
ο Draconis	280	+ 57	5
λ Antinöi	285	− 12	5
ι Andromedæ	350	+ 37	7

I have given the number of meteors conformable to each position, but this detail cannot be very precise, inasmuch as in several instances the path converged back on two radiants in the same line, and near together. In such cases it is often quite impossible to assign the true focus. Of the nineteen showers included in the list, sixteen of them come near the dates and places of radiants enumerated in Mr. R. P. Greg's catalogues.

The shower at 290° + 43° is apparently new for the first half of July, and corroborates one I deduced from the Italian meteor catalogue (1872) at 291° + 45° for June 26 to July 11 from eight meteors. This position falls near an August shower (seen on the 10th in 1871 at 293 + 42), and it is very likely to be nothing but an early indication of that system. The radiants in Perseus at 47° + 45° and 36° + 47° are too far removed from any previously known centres to be included with them. They were very swift, white meteors, rather bright, leaving streaks, and I mistook them at first for early *Perseïds* of the true August system. The positions agree singularly well with two of Prof. Herschel's cometary radiants and dates (British Association report on luminous meteors, 1875, p. 233) as follows:—

	R.A.	Dec.	Date.
Comets radiant (1764 ☊) ...	49°	+ 45°·5 ...	July 25.
Meteor radiant, 1877	47	+ 45 ...	July 12-20.
Comets radiant (770 ☊) ...	39	+ 45 ...	July 8.
Meteor radiant, 1877	36	+ 47 ...	July.

I saw several meteors from these radiants in July last year, and on examining the shooting-star catalogues of Zezioli, Schiaparelli, Denza, and others, 1867-72, have found a few additional paths clearly confirming the existence of these new meteor orbits. From twenty-eight shooting stars (including my own observations) the two showers are apparently well marked and fall sufficiently near the cometary positions to afford an inference of connection.

The most active shower of the month was from Andromeda (4° + 35°). Twenty-one swift white meteors were noted from this place, but the radiant was a little diffuse and not nearly so sharply centred as another strong system at 6 + 53, which supplied very similar meteors. They are both already well-known showers. On the early morning of the 29th a few swift meteors with streaks, observed in Auriga, indicated the commencement of the August *Perseïds* with radiant near *η Persei*.

Bristol, July 31 W. F. DENNING

OUR ASTRONOMICAL COLUMN

THE TOTAL ECLIPSE OF THE MOON, AUGUST 23.—Though lunar eclipses have lost the degree of astronomical interest and utility formerly attached to them, the general observer may still be expected to find the same amount of attraction as in past times in watching the physical features of a total eclipse of our satellite, well visible at a convenient hour of a summer's night. On Thursday evening, August 23, with favourable weather such a phenomenon may be witnessed, throughout its continuance, in this country as in other parts of Europe. The first contact with the penumbra takes place at 8h. 3·7m. Greenwich mean time, and that with the dark shadow at 9h. 13·7m., about 59° from the northernmost point of the moon's limb towards the east; the total phase begins at 10h. 19·1m., and ends at 3·7m. after midnight; the last contact with the shadow occurs at 1h. 9·1m. A.M. (August 24), about 112° from the northernmost point towards the west, and that with the penumbra at 2h. 19·1m. With respect to the earth's true shadow the eclipse, therefore, continues 3h. 45m., and the moon is totally immersed in it for 1h. 45m., the middle of the eclipse at 11h. 11m. P.M. When she first encounters the earth's dark shadow her altitude at Greenwich is 18°.

Though we are accustomed to speak of a total eclipse of the moon, as is well known, it rarely happens that she disappears while in the earth's shadow. The physical features of interest to which allusion is made above consist chiefly in the variations of the coppery and other tints which spread over her surface, and in the great majority of eclipses render her more or less conspicuously visible, during her passage through the shadow; and as these variable features depend upon the state of the atmosphere at the time round the edge of the earth's disc as seen from the moon, with respect to transparency or more or less prevalence of cloud therein—the aspect which a particular eclipse is likely to present does not admit of prediction. In the eclipse of June 15, 1620, Kepler states that the moon wholly disappeared, while stars of the fifth magnitude were visible in the neighbourhood, and Hevelius failed to see her, even with a telescope during the eclipse of April 14, 1642 (not April 25, as stated in many astronomical treatises). But perhaps one of the most striking instances of the kind is afforded by the eclipse of May 18, 1761, observed by the Swedish astronomer Wargentin at Stockholm; eleven minutes after the total immersion he could not perceive the slightest trace of the moon either with the naked eye or with the telescope, yet the night was very clear and the stars shining in her vicinity; but about forty minutes later, with a two-foot telescope, he discovered our satellite by a faint light on the border of the disc. As an instance of the contrary nature, where the moon has been so strongly illuminated during her presence in the shadow, as to admit of the various markings upon her surface being seen with distinctness, and even to lead persons to doubt her being eclipsed, mention may be made of the eclipse on the morning of December 23, 1703, which was observed by various astronomers in the south of France. At Avignon, during the whole duration of the passage through the earth's shadow, "the moon appeared extraordinarily illuminated, and of a very bright red, so that it might have been supposed that she was transparent, and that the sun was behind her globe, and that his rays passed through in the same manner that they are seen to traverse certain stones, which are slightly diaphanous." It is singular, however, that while this was the aspect of the phenomenon at Avignon, different features should have been noted at Montpellier, particularly the total disappearance of the moon, rather quickly towards 6h. 30m. A.M., though the night was as transparent as could have been wished; it is mentioned that the twilight was already very sensible, but that the invisibility of the moon could not be wholly attributed to this cause, since many stars were shining in the same quarter of the sky. A later instance of the same kind occurred on March 19, 1848, recorded by observers in England, Ireland, and Belgium, when the moon's disc was intensely bright, coppery red. The uninitiated were doubtful of there being any eclipse. It is worthy of mention that conspicuous aurora borealis was present during the night.

THE VARIABLE STAR χ CYGNI.—Prof. Schönfeld's ephemeris fixes the next minimum of this star to September 15, the magnitude according to his last catalogue of elements being then 12·8; but the variation has been subject to considerable irregularity of late years, and observations will be required for some time before and after any dates now predicted to determine the epochs of maxima and minima satisfactorily. The error of Argelander's formula, with one perturbation, appears to have attained a maximum of about three months, in 1870, and to have been since diminishing; as compared with the maximum of 1874, the error was little over two months.

This star is properly designated χ Cygni, Bayer's letter undoubtedly applying to it. χ of Flamsteed must then take the number he attaches to it, 17. When the British astronomer looked for Bayer's star it would be, as Argelander has pointed out, invisible; and hence his mistake in connecting another star with Bayer's letter; there is no necessity, however, to perpetuate the obvious error.

NEW MINOR PLANET.—No. 173 of the group of small planets was discovered by M. Borrelly at the observatory of Marseilles on the evening of the 2nd inst. At 9h. 0m. m.t., its position was in R.A. 22h. 40m. 30s., N.P.D. 97° 34'·8; diurnal motion in R.A. 26s., in N.P.D., + 8', a tenth magnitude. Though several small planets detected within the last ten years are adrift, it does not appear that the present body can be identical with any one of them. Ephemerides for 1877 of a number discovered since 152 are unavoidably omitted in the *Berliner Jahrbuch* for 1879, for want of the necessary elements. Dike, which was found by M. Borrelly as far back as May, 1868, has not been observed since.

BIOLOGICAL NOTES

TEMPERATURE OF TREES.—Prof. Boehm has recently investigated the temperature of trees in its relation to external influences. His conclusions are these:—1. The temperature of the tree-interior is, during transpiration, the combined expression of the air and the ground heat. 2. The air heat is conducted transversally, the ground heat longitudinally. 3. The longitudinal conduction is effected through the ascending sap-current, or rather through transpiration. 4. A lowering of the ground temperature during transpiration produces also a depression of temperature in the tree-interior. 5. The influence of the temperature of the ascending sap-current decreases in the stem from below upwards, and from within outwards. 6. The amount of this decrease is determined by the amount of the transversely-conducted solar heat, and is in direct ratio with the diminution of the volume of the stem part, and the approximation to the periphery of the stem. 7. The lower part of the stem is still under the full influence of the ground heat, or rather of the ascending sap-current. 8. The vertical limit of this influence is lost in the ramification of the tree. 9. With exclusion of transpiration, and therewith of rise of sap, the temperature of the tree is simply dependent on that of the air. 10. A simultaneous cooling of the lower and upper part of the tree completely equalises the amounts of influence (opposite according to the height of the stem) of the two cooling "moments."

LATICIFEROUS VESSELS IN PLANTS.—We notice a very interesting Russian paper, by M. Schmahlhausen, just appeared, "Researches on the Vessels of Plants." The author shows that the growth of the vessels goes on in the same manner as that of the mycelium of parasitic Fungi in the tissues of plants, and thus refutes the often expressed opinion that vessels in plants are analogous to the blood-vessels in animals.

FLORA OF NEW GUINEA.—Baron Ferdinand von Müller's fifth contribution towards a list of Papuan plants has recently reached us, and contains the remainder of the species, with few exceptions, gathered last year by Signor D'Albertis and Mr. Goldie, on their now famed New Guinea exploration. In this list several new species occur, notably a *Sloanea*, which Baron Müller has named *S. paradisearum*, from the fact that the tree, which grows to the height of forty feet on the Upper Fly River, inhabits the forest haunts of the birds of Paradise. The fruits are described as closely approaching in size those of *S. jamaicensis*, "thus far excelling any of the Sloaneas of the eastern hemisphere, so far as they are known, in the magnitude of the fruit." The discovery of *Nageia Rumphii* is interesting, from the fact that no other conifer is reported from New Guinea, except *Nageia thevetecæfolia*, and an Araucaria by Beccari.

THE SEGMENTATION OF THE HEAD.—By slow degrees an approach is being made to a true understanding of this most difficult and interesting question. The old explanations by archetypes and by the structure of the highest-developed skulls, have fallen into disfavour. Attempts to settle the cranial segments by considering the distribution of nerves in the adult have been shown to be unsafe, because nerves are necessarily adaptational in their character and liable to the greatest modification on changes taking place in the organs they supply. The development of nerves, however, is a much surer guide, showing primitive and fundamental characters. The nerves behind the ear are five in fishes, although the number of strands of which the vagus is made up in some cases points to a loss of distinct nerves and segments in the hinder part of the head. The auditory and facial nerves originate as one, so that the auditory appears as a specialised portion of the facial. The trigeminal likewise arises as a single nerve, and in front of this there is no nerve having a similar history to these and the spinal nerves. Thus we have an indication of seven segmental nerves issuing from the brain-case. When the visceral clefts are considered, we find in sharks six clefts indicating seven segments, or one more if the mouth be regarded as a cleft. The head-cavities between the outer wall of the head and the mucous membrane of the throat, discovered by Mr. Balfour in sharks, furnish a similar number. They are eight in all, one premandibular, one mandibular, one hyoid, and five branchial. Thus the examination of three sets of organs leads to the assignment of eight body segments to the head. But the question is far from being settled so long as the brain-case itself and the brain cannot be satisfactorily explained.

THE CAPERCAILZIE IN NORTHUMBERLAND.—It is well known that this fine bird, originally indigenous in the British Islands, became extinct, and was reintroduced into the Scottish Highlands some forty years ago by the late Marquis of Breadalbane. Earl Ravensworth has recently been endeavouring to naturalise the capercailzie in large tracts of pine wood in Northumberland, on the edge of moors and wild crags, furnishing various berries which form its favourite food. In 1872 a cock and two hens were reared; but the male bird got destroyed. In 1873 two settings of eggs were hatched, but owing to a wet summer all the young birds perished after nearly arriving at maturity. In 1874 four fine birds were reared to their full growth, one of which, a male, still survives. In 1876 fifteen chicks were hatched out of twenty eggs, and three cocks and four hens grew to maturity. But the stock has become reduced to five individuals, three males and two females, all in good health. It appears that a difficulty arises from some deficiency in diet or conditions which is at present unknown. Although extremely wild and shy by nature, and flying long distances, capercailzies are yet most indolent, and unwilling to move from places to which they are familiarised. Their colour assimilates very closely with the Scotch fir, so that it is exceedingly difficult to distinguish the male bird when seated on a branch. The male is very ferocious, and makes extraordinary gesticulations during the season of courtship; the hen may even be killed by his fierce advances.

EVOLUTION BY LEAPS.—Mr. Thomas Meehan has described before the Academy of Natural Sciences of Philadelphia a case of sudden change of characters in some branches of a "smoke-house" apple tree, which bore clusters of flowers at the ends of young shoots, flowering six weeks after the ordinary blooms from spurs, and yet maturing fruit at the same time as the old spurs. This fruit, however, was very unlike the smoke-house fruit, the fruit stems being long and slender, and the fruit flattened. The change was so great that a botanist would have no hesitation in describing the form as a new species; and there appeared no reason why the law which produced this modification might not simultaneously act on all the trees in a district. At any rate here was an appearance which served to show how new species might arise in nature. Mr. Meehan, however, did not allude to the difficulty of reasoning from a change in a cultivated variety to the operation of causes in a wild state. The case can hardly be considered as decisive, although of much interest.

THE EUCALYPTUS IN THE UNITED STATES.—Mr. Joseph Wharton has tried to acclimatise *E. globulus* in Philadelphia, but although the plants grow well in greenhouses, they seem incapable of surviving the severe winters, even though carefully covered with leaves and earth. The winter test was only applied after the plants had grown vigorously for some years, being protected in winter and placed in the open air in summer.

EVOLUTION OF NERVES AND NERVO-SYSTEMS[1]

III.

THE question, however, remains: Will this conductile function prove itself as tolerant towards section of the tissue as the contractile function has already proved itself to be? for, if so, any objection to the view that the passage of the *contractile* waves is due to vicarious action of rudimentary nerve-fibres will be removed. Briefly, the answer to this question is an affirmative; for I find it is quite as difficult to block the passage of stimulus waves by means of interposing cuts, as we have seen that it is to block the passage of contractile waves by the same means. For instance, here is an *Aurelia* (Fig. 5), the bell of which has been cut into the form of a continuous parallelogram of tissue, and then submitted to the tremendously severe form of section which is depicted. Yet on very gently stimulating any point in this expanse of tissue, as at the end *a*, a tentacular wave would course all the way along the margin, to *b*, thus showing that the wave of stimulation must have passed round and round the ends of all the intervening cuts. In the diagram the tentacular wave is represented as having traversed one-half of the whole distance from *a* to *b*, and near *b* there is represented a single remaining ganglion, (*g*). When, therefore, the tentacular wave reaches *g*, this ganglion will shortly afterwards discharge, so giving rise to a contractile wave, which will course back from *g* to *a* in the opposite direction to that which the stimulus wave had previously pursued.

And this, I am not afraid to say, is the most important observation, both to the physiologist and to the evolutionist, that has ever been made in the whole range of invertebrate physiology. For to the physiologist this observation proves that the distinguishing function of nerve, where it first appears upon the scene of life, is a function which admits of being performed vicariously, to almost any extent, by all parts of the same tissue-mass; while to the evolutionist the observation proves the existence of such a state of things as his theory of nervogenesis would lead him to expect. In such a symmetrically-formed animal as a Medusa, with all parts of the contractile sheet precisely resembling one another, we should expect the lines of discharge composing the hypothetical plexus to be very numerous, and all very much alike with respect to the degree of their evolution. For, as the symmetrical form of the disk does not require that any one set of lines should be used much more frequently than any other set, it follows from Mr. Spencer's theory that all the lines should more or less resemble one another as regards the extent of their differentiation.[2] That is to say, they should all be lines presenting about the same degree of resistance to the passage of a stimulus wave, and therefore it should become a matter of indifference, so to speak, through which particular set of lines such a wave takes its course.

There is still another class of facts which to my mind makes very strongly in favour of Mr. Spencer's theory. Assuming, as I think we are now entitled to assume, that the contractile waves are not merely muscle waves, but depend for their passage on the progressive passage of the stimulus waves—assuming this, the following facts become facts of great significance. When the contractile waves in a spiral strip have become suddenly blocked by section, in the great majority of cases, such blocking will be permanent—even though the strip be continously stimulated, whether artificially or by a single terminal ganglion, as represented in Fig. 4. But in the remaining cases, after a time that varies from a few minutes to a day or more, the obstruction is overcome, and the contractile waves pass forward with perfect freedom. Now, if I had time, I could prove that these facts are certainly not to be attributed to what physiologists term *shock;* and, therefore, it seems to me that only one hypothesis remains. What I have recently said about most of the lines of discharge in the supposed plexus being very much alike as regards the degree of their differentiation, does not, of course, mean that all the lines are *exactly* alike in this respect; for on *à priori* grounds such a state of things would be in the last degree improbable. Consequently, in conducting a spiral section, it must happen that at every snip the scissors cut through a number of lines of discharge presenting various degrees of differentiation; and, such being the case, the fact of the sudden and final blocking is presumably due to a well-differentiated line having been severed in a part of the tissue where no other line occurs of a sufficient degree of differentiation to conduct the stimulus forward. Now in most instances, as we should expect, the blocking so caused is permanent; for it is manifest that the formation of nervous channels, in the way suggested by Mr. Spencer, cannot proceed at so great a rate as to admit of *wholly* new lines of discharge being established during the life-time of a mutilated Medusa, *i.e.*, during the course of a few days. Nevertheless, according to the hypothesis, some small percentage of cases might be expected to occur in which such blocking of the contractile waves would only be temporary. For some cases would almost certainly occur in which the relations of the highly differentiated line just destroyed to the more slightly differentiated lines in the neighbourhood of the section, would happen to be such that the more slightly differentiated lines would be very nearly, though not quite, able to act vicariously for the more highly differentiated line which has just been destroyed (see Fig. 4, where the deep line represents the well-differentiated line which has just been severed, and the dotted line the less-differentiated one which is still intact). The contractile waves, therefore, would in the first instance become suddenly blocked at the end of the strip. But the molecular, and with them the contractile, waves still continuing to pass quite up to the end of the strip, and being there always suddenly stopped, a rude conflict of molecular forces will thus set up in the area where these waves are impeded, and each of the forces concerned will seek for itself the line of least resistance. Hence, as the successive waves beat rhythmically on the area of obstruction, more or less of the molecular disturbance must every time be equalised through those lines of discharge which from the first have been almost sufficient to maintain the physiological continuity of the tissue. Therefore, according to the hypothesis, every wave that is blocked imposes on these particular lines of discharge a much higher degree of functional activity than they were ever before required to exercise; and this greater activity causing in its turn greater permeability, a point will sooner or later arrive at which these lines of discharge from having been *almost* become *quite* able to draft off sufficient molecular motion, or stimulating influence, to carry on the contractile waves beyond the area of previous blocking. In such instances, of course, we should expect to find, what I always observed to be the case, viz., that the first contractile waves which

[1] Abstract of a Lecture delivered at the Royal Institution on Friday evening, May 25, 1877. By George J. Romanes, M.A., F.L.S., &c. Continued from p. 271.

[2] Mr. Spencer himself observes, "The average equality of the forces to which their bodies (*i.e.*, those of the Medusæ) are exposed all round is unfavourable to the formation of distinct muscles and a distinct nervous system" ("Psychology," vol. i. p. 522) Although this statement must now be modified so far as the ganglionic system of the Medusæ is concerned, I do not think that the anticipation which it embodies should on this account be deemed unwarrantable so far as it applies to other parts of the nervous system. For although it is true that a Medusa *as a whole* is "exposed all round" to an "average equality of forces," it is not true that the *excitable* portions of a Medusa are thus equally exposed. On the contrary, the margin of the excitable sheet which lines the cavity of the bell, occupies a much more exposed position than does any other part of that sheet; and whether or not this fact has anything to do with the development of the ganglia in the only part of the excitable sheet which is thus peculiarly situated, I think it is obvious that this part of a Medusa ought to be carefully excepted in the statement which I have quoted. With regard to all other parts of the excitable sheet, however, the statement is certainly correct; and it is only to such parts that the considerations in the text apply.—G. J. R.

pass the barriers are only very feeble, the next stronger, the next still stronger, and so on, according as the new passage becomes more and more permeable by use; until at last the contractile waves pour over the original barrier without any perceptible diminution of their force. In some cases, by exploring with graduated stimuli and needle-point terminals, I was able to ascertain the precise line through which this eruption of stimulating influence had taken place; so that altogether I think these facts tend very strongly to confirm Mr. Spencer's theory regarding the genesis of nerves.[1] I will only add that if this interpretation of the facts is correct, we have in them a striking instance of the uniformity with which Nature works. A scientific theory concerning the evolution of nerves, which a year or two ago it seemed impossible to verify, from the fact that it seemed as though the observations which would be required to verify it would need to extend over thousands of years—this theory is now, I believe, being verified by observations which need only extend over hours and minutes. The immensely protracted history of nervo-genesis upon this planet is thus probably reproduced in a greatly foreshortened manner in the facts which I have explained; and inconceivable as is the difference between these two histories of nervo-genesis in respect of their duration, it is nevertheless most probably in respect of their duration alone that these two histories differ.

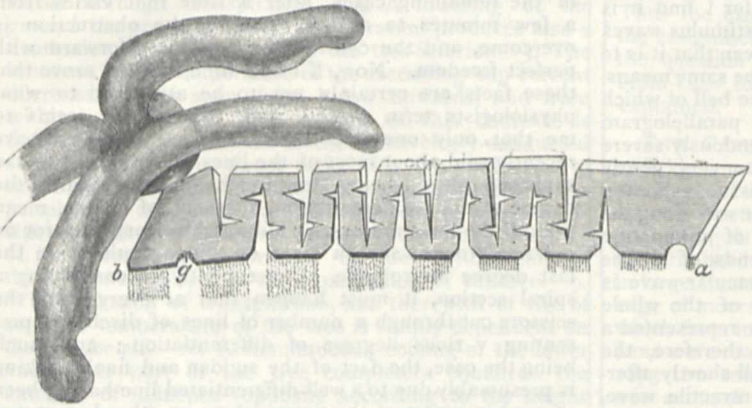

FIG. 5.

I will now invite your attention to another species of Medusa, which is of a somewhat more highly evolved type than *Aurelia*, and which I have called *Tiaropsis indicans* (Fig. 7), in allusion to a highly interesting and important function which is displayed by its polypite. This function consists in that organ localising, with the utmost precision, any point of stimulation situated in the bell. For instance, if the bell be pricked with a needle at this point (*a*), the polypite immediately moves over and touches that point, as represented in the diagram. If immediately afterwards any other part of the bell be pricked, the polypite moves over to that part, and so on. Now this, you will perceive, is a highly remarkable function; for it proves that all parts of the bell must be pervaded by lines of discharge, every one of which is capable of conveying a separate stimulus to the polypite, and so of enabling the polypite always to determine which of the whole multitude is being stimulated. This localising function of the polypite, therefore, shows that the lines of discharge must be more differentiated in this species than they are in *Aurelia;* for it shows that vicarious action cannot be possible among them in so high a degree: every line of discharge must here have acquired a more specialised character, in order that the message which it conveys to the polypite when itself directly stimulated may not be confused with that which is conveyed by any other line.

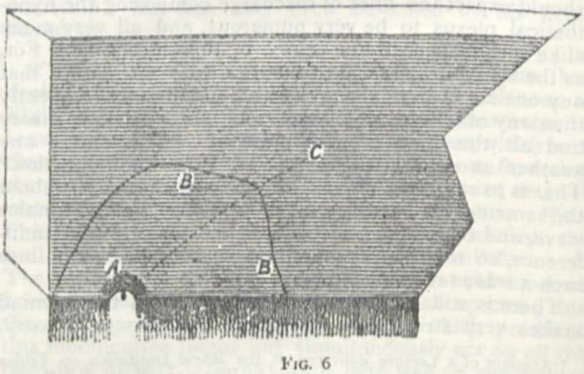

FIG. 6

Now it is easy to be wise after the event; but the state of things we here observe is just such a state of things as I think we should expect to constitute the next stage of nervo-evolution. It is no doubt a benefit to this Medusa that its polypite is able to localise a seat of stimulation in the bell; for the end of the polypite is provided with a stinging apparatus, and is besides the mouth of the animal. Consequently, when any living object touches the bell—whether it be an enemy or a creature serving as prey—it must alike be an advantage to the Medusa that its polypite is able to move over quickly to the right spot,

[1] As additional proof that a wave of stimulation may pass over a barrier of the kind described in too small a quantity to start a wave of contraction beyond the barrier, I may mention the following facts:—In *Aurelia* the polypite is more sensitive to stimulation of the bell than is the bell-tissue itself; so that it is possible to stimulate the bell-tissue too gently to start a contractile wave in it, and yet strongly enough to cause writhing motions of response on the part of the polypite. Now, if by means of a spiral section of the bell the contractile waves have become blocked in the ribbon-shaped strip, it is sometimes possible, by strongly stimulating this strip, to cause the writhing motions of response on the part of the polypite—thus showing that although the contractile waves are blocked by the spiral section, the stimulus waves are able to pass forward with a strength sufficient to cause response in the polypite. I may here add that this fact of the contractile waves being sometimes wholly blocked by section before the stimulus waves are so, would appear to exclude, in the case of the Medusæ at all events, Kleinenberg's view as to the functions of primitive nerve and muscle being blended in the same tissue-elements. (See his work on *Hydra*.) I may also mention that in some cases I have observed that the establishing of a new line of physiological connection is a more gradual process than stated in the text. To show this, I may briefly quote one very instructive case. Seven marginal bodies having been removed, the eighth one continued to originate contractile waves, which coursed round the swimming-bell as usual. I now made a radial cut half an inch on one side of the marginal body, and extending to the centre of the swimming-bell. The contractile waves were immediately blocked—thus showing, as did a somewhat similar experiment detailed in my first Royal Society paper (p. 293), "that the influence of the marginal body had previously been communicated to the swimming-bell *from one side only*." But in the case we are now considering, the discharges of the marginal body were still rendered apparent by very local contractions of a tissue area in the immediate vicinity of that body—the area, namely, which in the figure (Fig. 6) representing one end of the strip is marked B B. Exploration by stimulus now showed that general contractile waves could only be started outside the area B B. In somewhat more than half an hour after the operation (during which time the area B B continued to contract rhythmically), the ganglionic influence for the first time extended from the area B B to the rest of the strip—the contraction being therefore general. After this first eruption of contractile influence, there succeeded a period of about a minute, during which the area B B continued to contract independently as before. Then another eruption took place, followed by another period of restricted contraction, and so on. Next, these general contractions became progressively more and more frequent, and as the rhythm always continued the same, whether the contractions were local or general, the number of the latter became increased at the expense of that of the former. Thus, while at first there were twenty or thirty local contractions between every two general contractions, this proportion gradually fell to fifteen, ten, five, &c., till the numbers became equal, after which the balance began to incline in favour of the general contractions. Eventually the local contractions ceased altogether, and on now excising the marginal body and exploring by stimulus, I was able to localise very precisely the line through which physiological continuity had been established between B B and the rest of the contractile strip. This line was A C, as shown by the fact that while stimulation of any other part of the area B B was followed only by a local contraction at that area, stimulation of the line A C was always followed by a general contraction.—G. J. R.

in the one case to sting away the enemy, and in the other to capture the prey. Hence I think that natural selection would probably tend to convert lines of discharge in promiscuous directions, into lines of discharge in definite directions—thus developing the function of localisation. At first, no doubt, this function would be performed only in a general and tentative manner (as, indeed, I have observed in the case of *Aurelia*); but gradually by the combined action and mutual reaction of use and survival of the fittest, this function would come to be performed with ever-increasing precision.[1]

This, then, I conceive to be an important step in the evolution of nervous systems—foreshadowing as it does the principle of co-ordination among muscular movements, which in all the higher animals is effected by reflex mechanisms precisely resembling, as to their function, the primitive reflex mechanism we are considering. But now another point of interest arises. As Spencer's theory supposes a line of discharge to become more and more definite by use, if, for the maintenance of any particular function such as the one we are considering, a certain line of discharge habitually serves as a line of communication between two points of the animal tissues; it follows that this line will offer less resistance to the passage of a stimulus between these two points than would any other line in the organism. Consequently, so long as such a line remains intact, so long we should expect what we have seen to be the case, viz., that little or no vicarious action takes place between it and other lines. But let this line be severed, and let there be a number of closely adjacent lines, as there must be in this particular instance, and should we not expect, both from Spencer's theory and

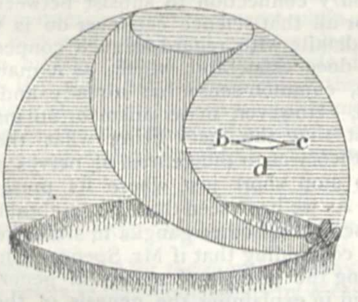

FIG. 7.—*Tiaropsis indicans*, slightly enlarged.

from our knowledge of *Aurelia*, that at some such grade of nervous evolution as *Tiaropsis* presents, the stimulus should be able to *escape* from the severed to the unsevered lines? And this I find to be the case. For if a small cut be introduced between the base of the polypite and the seat of injury in the bell, the polypite is no longer able to *localise* the seat of injury, although it still continues to perceive, so to speak, that injury is being applied *somewhere*. For instance, if a short cut be introduced as here represented at *b c*, and you prick the bell anywhere below the cut, as at *d*, the polypite, instead of immediately applying its extremity to the exact spot that is being stimulated, now actively dodges about first to one part and then to another part of the bell, as if seeking in vain for the offending body, which, however, it cannot succeed in finding. Now I explain this marked change in the behaviour of the polypite by supposing that the wave of stimulation in this case runs along the habitual line of discharge till it reaches the cut; and that being there no longer able to pursue this habitual line of least resistance, the wave of stimulation escapes into the adjacent lines, and so spreads all over the bell. Hence a number of conflicting messages are simultaneously delivered to the polypite, which therefore executes the random movements I have described—each of these movements being presumably determined by the relative degree in which now one line and now another takes part in conveying the scattered stimulus.

And now for another expectation to be realised. We should expect that the higher degree of specialisation which in these lines of discharge prevents vicarious action so long as the lines are undivided, should have the effect of rendering such vicarious action as we have seen to ensue when the lines are divided, less easy than it is in *Aurelia*, where the specialisation of the lines being less pronounced, vicarious action among them is presumably more habitual. And such I find to be the case; for while in *Aurelia*, as we have seen, stimulus-waves continue to zig-zag round and round the ends of almost any number of overlapping cuts, in *Tiaropsis* two or three such cuts are sufficient to destroy, not only the localising, but also the random movements of the polypite—the latter then remaining passive, because the stimulus-waves are wholly blocked.

And lastly, before leaving the case of *Tiaropsis indicans*, I should like to mention the noteworthy fact, that although the polypite is able to perform the intricate ganglionic *function* of localising any seat of stimulation in the bell, no signs of ganglionic *structure* can be detected with the microscope. Moreover, a portion of any size that is removed from the polypite continues to perform the localising function in just the same way as does the entire organ. In other words, this localising function, which is so very efficiently performed by the polypite of this Medusa, and which, if anything resembling it occurred in the higher animals, would certainly have definite ganglia for its structural correlative, is here shared equally by all parts of the exceedingly tenuous excitable tissue that forms the outer surface of the organ. The case of the incipient ganglia of the polypite thus resembles that of the incipient nerves of the bell in this respect—that in both cases obvious signs of characteristic function are displayed before any corresponding signs of structure can be distinguished. Nerve-cells, therefore, no less than nerve-fibres, are thus shown to have their first beginnings in differentiations of protoplasmic substance which are too refined for the microscope to analyse.

There is one other species of Medusa about which I should like to say a very few words, because it presents a still higher grade of nervous evolution than *Tiaropsis*. This is *Sarsia* (Fig. 8), a Medusa in which the lines of discharge have in some places become so far differentiated as to admit of being actually seen, and are therefore entitled to be called nerves. All round the margin, and likewise along the course of the radial tubes, these, the earliest visible nerve-fibres in the animal kingdom, may be traced. And as we might anticipate, the advance of structure which is implied by an invisible "line of discharge" becoming a visible nerve-fibre, entails a corresponding advance of function. In the first place, the rate at which a stimulus travels seems to be much greater along these fully-evolved nerve-fibres than it is in the more rudimentary nerves or lines of discharge in *Aurelia*. In the next place, this greater differentiation of nerve-tissue renders the nervous connection between any two parts of the organism much more definite, and therefore vicarious action less promiscuous, than we have seen it to be in the other jelly-fishes; so that, for instance, a tentacular wave in this species may be blocked by a single short cut through the margin of the bell. Lastly, it is in this species that I was first able to perceive any unequivocal evidence of co-ordination among the marginal ganglia. In all the other species of Medusæ the marginal ganglia appear to act independently of one another; but in this species, where the marginal ganglia are first seen to be united by a visible nerve-fibre, they always act in concert. So much, indeed, is this the case, that the animal is able to steer itself in any required direction, as proved by the experiment which

[1] It may be here observed that Mr. Spencer, in his theory of nervo-genesis, expressly supplements his hypothesis as to the direct influence of use, with that as to the indirect influence of natural selection. (See "Biology," § 164.)—G. J. R.

I described last year, whereby individuals of this species were shown to have the power of following a moving beam of light round and round the vessel in which they were contained. I may also remark that individuals of this species present much more nervous energy than those of any other species of Medusæ which I have had the opportunity of observing.

I have now, ladies and gentlemen, communicated some of the points wherein my work has tended to elucidate the early stages in the evolution of nerves and nervous systems. And these are just the stages concerning which elucidation is most required. When once nerve-fibres and nerve-cells have been fully evolved and arranged in the form of simple reflex mechanisms, the subsequent history of their evolution into compound nervous systems is readily intelligible. The principles on which this higher evolution is effected are throughout the same, and result essentially in establishing ever more and more advanced

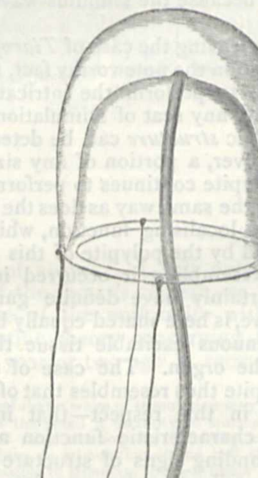

FIG. 8.—*Sarsia tubulosa*, × three times.

degrees of integration. Compare, for instance, the nervous systems of an earth-worm, a centipede, an insect, and a spider; and observe the progressive fusion of ganglia which has taken place. The progressive centralisation which is thus effected is no doubt ultimately due to natural selection, if not exclusively, at any rate in large part; for this increasing consolidation of the reflex mechanisms must be of great benefit to the organisms which present it—serving as it does to render possible muscular movements ever more and more varied and combined. In the vertebrated series of animals the evolution of central nervous matter consists chiefly in adding to the size of ganglia by increasing the number of their ultimate nervous elements, nerve-cells and nerve-fibres. This progressive increase in the size of ganglia is especially remarkable in the case of the cerebral hemispheres. Now the cerebral hemispheres are the ganglia which we know to be the exclusive seat of the intellectual faculties; and their progressive increase in bulk as we ascend through the animal series, is undoubtedly to be regarded as the structural correlative of that progressive advance of the intellectual powers which is so conspicuously apparent as we ascend from the lower animals to Man.

And now, in conclusion, I should like to observe, that even in this the highest product of nervous evolution—the supreme ganglia or cerebral hemispheres of Man—not only do we still encounter the same fundamental constituents of structure as we observe in all other ganglia; but the cells and fibres in the brain of a man do not differ in any marked degree from the cells and fibres in the ganglion of an *Aurelia*. There is, however, a prodigious difference in the product of their operation. When ordinary ganglion cells discharge their influence, the result is, as we have seen, a muscular contraction; but when cerebral cells discharge their influence, we of to-day can have no doubt that the result is a mental change. And although we freely acknowledge that we are here standing on the border-land of insoluble mystery, we are not afraid to assert with confidence, that in the amazing complexity of the brain's structure—amid those millions on millions of interlacing cells and fibres—we have the physical aspect of all those relations, which in their psychical aspect we know as thoughts and feelings. Do you think that this sounds like materialism? I am not here to-night to discuss that point; but I may observe in passing, that even were I able to tell you the particular cerebral elements which I now use in expressing this statement to you, I should be just as much or just as little on the way towards proving materialism, as I am when I tell you that a blow on the head produces insensibility. Science can never go further than common sense in proving any *necessary* connection to subsist between mind and matter; for all that science can ever do is to ascertain numerous details with regard to such connection as undoubtedly does exist, and which, as a matter of daily experience, common-sense has already and completely recognised. However, materialism or no materialism, it is manifest that the facts being what they are, Mr. Spencer's theory as to the genesis of nerves must not be allowed to stop short just where its presence is most required. As we have seen that the cerebral hemispheres of man resemble all other ganglia in structure, we cannot hesitate in concluding that if Mr. Spencer's theory is valid in explaining the genesis of nerves in general, it can be no less valid in explaining the genesis of these supreme ganglia in particular. And as we have every reason to believe that the functional operations of these supreme ganglia are inseparably associated with our thoughts and feelings, we are driven to the yet further conclusion, that if Mr. Spencer's theory is of any validity at all, our possible as well as our actual thoughts and feelings are determined by the strictly physical conditions under which molecular waves of stimulation course through the structure of the brain. So that in this Spencerian hypothesis of lines of discharge becoming more and more definite by use, we have a physical explanation, which is perhaps as full and as complete as such an explanation can ever be, of the genesis of mind. From the time that intelligence first dawned upon the scene of life, whenever a new relation had to be established in the region of mind, it could only be so established in virtue of some new line of discharge being excavated through the substance of the brain. The more often this relation had to be repeated in the mind, the more often would this discharge require to take place in the brain, and so the more easy would every repetition of the process become; until at last the line of discharge grows into a nerve-fibre, and becomes the inherited property of the race. Thus it is, according to the theory, that there is always a precise proportion between the constancy with which any relations have been joined together during the history of intelligence, and the difficulty which intelligence now experiences in trying to conceive of such relations as disjoined. Thus it is that, even during the history of an individual intelligence, "practice makes perfect," by frequently repeating the needful stimulations along the same lines of cerebral discharge—so rendering the latter even more and more permeable by use. Thus it is that a child learns its lessons by frequently repeating them; and thus it is that all our knowledge is accumulated. In a word, if, as has been truly said, "man is a bundle of habits," we have in Mr. Spencer's theory of nervo-genesis a physical explanation of the fact. And forasmuch as it is upon this theory that Mr. Spencer may be said to found that great monument of modern thought—his "Principles of Psychology," I cannot but feel that one of the most important bearings which my work on the Medusæ has had, is that of supplying facts which tend to substantiate this theory—and this at a time when it seemed as though the theory could never have other than *à priori* considerations for its support. But if my interpretation of these facts is correct, this important theory is now receiving inductive verification from a most unexpected source. At first sight no two organic structures could well seem to have less in common than the swimming-bell of a Medusa and the brain of a Man; nor could anything seem more unlikely than that a great psychological theory should derive support from the study of polypes, where the very existence of a nervous system has only just been discovered. But here again, I believe, we may discern the uniformity of Nature; and while watching the passage of the waves of stimulation in the contractile strips of *Aurelia*—now passing freely, now stopped by an excess of resistance, and now again forcing a passage,—I have felt that I was probably witnessing, on the lowest plain of nervo-genesis, that very same play and counter-play of forces, which, on the highest plain of nervo-genesis, invariably accompanies, if it does not actually cause, the most intricate reasoning of a Newton, the most sublime emotion of a Shakespeare, the most imperious will of a Napoleon, and the most transforming thought of a Darwin.[1]

[1] Throughout the lecture of which the above is a pretty full abstract, I have associated Mr. Herbert Spencer's theory of nervo-genesis with his name exclusively. To avoid misapprehension, therefore, I append this note to state that I am not ignorant of the fact that the theory in question has occurred to other thinkers as well as to the great English philosopher. Moreover, I am quite aware that even if this theory of nervo-genesis had never been enunciated *à priori* by any speculative thinker, some such theory would certainly have been devised *à posteriori* by any working physiologist of moderate capacity who might first happen to observe such facts as are above detailed. But considering that Mr. Spencer elaborated the theory deductively, and that he did so in a much more thorough and painstaking manner than had ever been done before, considering, too, that he has given the theory so elaborated such a prominent place in his system of objective psychology, I have not hesitated to describe this theory as being pre-eminently a product of his authorship.—G. J. R.

ATOMS AND EQUIVALENTS

IN the *Comptes Rendus* for the month of May and June there is a series of communications by Messrs. Wurtz and Berthelot containing a discussion of their respective views as to whether chemical changes should be expressed by elements in equivalent proportions or whether the more modern system of atomic weights should be employed.

In the first communication, which is made by M. Wurtz, he remarks on the discrepancy evidently existing between his idea and that of M. Deville, "who has criticised him in a former number of the journal," on the law of volumes of Gay-Lussac. He advances in support of the atomic argument, that free hydrogen may be regarded as a combination of two atoms of hydrogen, the peculiar reaction of hydrochloric acid on hydride of copper and in the case of oxygen with oxygen the reactions discovered by Thenard and Brodie of peroxide of hydrogen on certain oxides. He maintains that the molecular conceptions with regard to bodies in the free state are further upheld, in the case of nitrogen by the formation of nitro and dinitro compounds, and in the case of carbon by the consideration of organic chemistry when examined according to the theory of Kekulé of the grouping of several carbon atoms in the same molecule. After discussing the law of Gay-Lussac as applied to the gaseous compounds of hydrogen with chlorine, oxygen, and nitrogen, he remarks that what results from the previous discussions on this matter, is, that the system of expressing chemical reactions by equivalents which prevailed about 1840 over the atomic notation of Berzelius, has not taken into proper account the discoveries of Gay-Lussac on the combination of gases with each other; and consequently, that the maintenance of this principle in the discussion of chemical phenomena would cause a serious obstacle to the advancement of the science.

M. Berthelot on behalf of those who, like himself, retain the method of writing chemical changes by equivalents, as opposed to the atomic notation, in replying to this first communication of M. Wurtz, states that he does not think the matter to have the same importance which the latter seems to attach to it. He considers that the progress of chemical science is not entirely subordinate to a change of notation which does not strike at the foundation of the science as it had done a hundred years ago to the pneumatic chemistry of Lavoisier. He thinks that at the present day the truths are so general that all the laws may be expressed to a certain extent by both languages with equal clearness and precision. With regard to the view put forward by Wurtz, that bodies in the free state are composed of two atoms, and in support of which view he has mentioned the reactions of hydrochloric acid on hydride of copper, and peroxide of hydrogen on oxide of silver, $Cu_2H + HCl = CuCl_2 + HH$, and $Ag_2O + H_2O_2 = Ag_2 + H_2O + OO$. M. Berthelot deems the explanation given by M. Wurtz mere assumption, without sufficient proof, tending to prevent a true understanding of the real cause of the reaction. He also considers that the true explanation might be found in and explained by certain thermical considerations.

M. Berthelot passes next to a criticism of the atomic method of expressing the reactions of certain metallic salts with each other, and complains of the doubling of the equivalents of certain bodies, such as $CaCl_2$, which he thinks makes an unnecessary complication in the expression of the reactions, and gives as an instance the reaction of certain nitrates with chlorides. By the system of equivalents, he maintains they might be expressed by one reaction—$MNO_6 + M'Cl = MCl + M'NO_6$—but that by the atomic notation four different and distinct reactions are necessary to express their decomposition.

M. Berthelot then alludes to the confusion he thinks has arisen between the words law and hypothesis, in the acceptance of Avogadro's law. In this case he maintains that Avogadro and Ampère have enunciated, not a law, but an hypothesis, in saying, "All gases contain the same number of molecules in the same volume," having, in reality, nothing by which to conceive the idea of a molecule. On the other hand, he thinks the proposition, "The densities of gases or vapours are proportional to their equivalents," being deduced from two orders of properties observable by experiment, may be regarded as a true law. Partisans of the atomic notation have, he considers, substituted for this the proposition, "Molecules of simple gases contain the same number of atoms," and he complains that they thus introduce two hypothetical notions, that of the molecule, and that of the atom. On the other hand, supporters of the system of equivalents say, "Equivalent weights of simple or compound bodies occupy the same volumes;" or the volumes are to each other in the simple ratios, 1, 2, 3, 4, &c., thus:—

1 equivalent of oxygen occupies 1 volume.
1 " Cl, H, or Hg occupies 2 volumes
1 " HCl occupies 4 volumes, &c.

M. Wurtz, on the other hand, replaces the above by the statement, "All gases contain the same number of molecules;" the molecule may then be formed—

It may be by 1 atom, as Hg, Cd, &c.
„ 2 atoms, as H, Cl, O, &c.
„ 3 „ „ Ozone.
„ 4 „ „ P, A, &c.

What is there in this, M. Berthelot asks, more logical than in his own method? or in what may it be allowed to constitute a modern chemistry in distinction to that of Lavoisier and of Gay-Lussac?

In answer to M. Berthelot, M. Wurtz discusses in a further communication the thermic considerations brought forward by the former in his explanation of the reciprocal reactions already alluded to of hydride of copper with hydrochloric acid and peroxide of hydrogen with other peroxides. M. Wurtz, although acknowledging the value of these considerations, considers the reasoning incomplete, by merely saying that hydride of copper is an endothermic compound; it would be necessary to prove in addition why such bodies, having a greater capacity of heat than their constituent elements, can be formed or exist at all. He maintains that his own ideas admit of the intervention in the thermic considerations relative to the formation of such bodies as peroxide of hydrogen, ozone, chloride of nitrogen, &c., the work done in doubling the molecules of oxygen, O_2, chlorine, Cl_2, and nitrogen, N_2; this work causing an absorption of heat. He brings forward the ideas of M. Favre regarding the formation of bodies with an absorption of heat and alludes to the idea of this latter chemist of representing free oxygen as O_2 and nascent oxygen as O, the latter being more active in consequence of being supplied with more heat from what he calls the "segregation" of the molecule. M. Wurtz concludes that the thermical reasoning instead of being opposed to the atomic conception materially assists it.

In passing to the further objections made by Berthelot to expressing the reaction of potassium and hydrochloric acid as—

$$2HCl + K_2 = 2(KCl) + H_2,$$

M. Wurtz explains it as a necessity to render it comparable to the reaction—

$$2HCl + Zn = ZnCl_2 + H_2,$$

this representing 63·5 of zinc or two equivalents, having doubled the equivalent of zinc, as also of certain other metals for two reasons: firstly, to allow them to accord with the law of Dulong and Petit; and secondly, to satisfy Avrogadro's law. M. Wurtz evidently considers M. Berthelot in the position of almost wishing the abolition of Dulong and Petit's law, and explains that although the product of the specific heats into the atomic weights may not always prove rigorously constant, still they are sufficiently near, it being difficult to obtain one and the same metal under conditions strictly comparable. He wishes therefore to retain the law of Dulong and Petit as a check for the determination of the atomic weights. The notation of equivalents, he thinks, contains certain inconsistencies, and complains that no direct response has been made by its upholders to this point, which is really at the foundation of the discussion; they have only objected to atomic notation as introducing vexatious complications in expressing the reactions of mineral chemistry.

To M. Berthelot's reproach that he has confounded the notion of a hypothesis with that of a law, M. Wurtz replies in the following sentence:—"Je le remercie de cette leçon de philosophie; mais je ne crois pas en avoir besoin." He admits, for his own part, his knowledge that the notion of atoms and molecules is only a hypothesis, one which it is allowable to make on the constitution of matter, and essentially dependent on another, that of the existence of the ether. M. Berthelot believes the atomic hypothesis ill-founded, as atoms and molecules have never been seen, but for the same reason it would be as difficult to imagine the ether. To reject this latter hypothesis it would be necessary to adopt that of continuous matter of differing degrees of density filling all space, and M. Wurtz repeats that chemical notation, the point in question, is independent of such hypotheses.

The notion of atoms and molecules would have to be replaced by that of infinitely small vibrating masses, and at the basis of the notion of equivalent quantities lies the same idea of finite particles. What is really necessary is the choice of exact numbers to express the relative weights of these particles by whatever name they may be called; according to M. Wurtz they are of two orders: isolated, he calls them atoms; combined, molecules. Is this, he asks, an ill-defined idea?

In a discussion like the present, which has existed for so long, and which doubtless will still be continued, it is extremely difficult to balance accurately the arguments used by the upholders of the different theories. Although many and forcible reasons have been brought forward by both contending parties, we fear that no final victory has been gained by either side. M. Berthelot objects to the idea of molecules and atoms, but he evidently does not wish to exclude entirely imagination and hypothesis from scientific reasoning, and deems, as is probably the case, that the fundamental conceptions of the two chemical schools may not differ so much in that matter as perhaps M. Wurtz at present imagines.

The point on which the real difference seems to exist is, in perceiving the true importance of such representative conceptions, and placing them in the position they should occupy in human knowledge. J. M. T.

THE GREENLAND FOEHN [1]

ONE of the chief peculiarities of the meteorology of the Arctic regions, and particularly of West Greenland, is the great variability of the temperature in the cold part of the year. There may not only be a very considerable variation in the average monthly temperature from year to year, but sudden changes from the severest cold to fresh weather, and *vice versâ*, often occur several times in the course of the same month.

Dr. Pfaff has carried on meteorological observations at Jacobshavn for twenty years, and these show that the average temperature of 1872 was −8·7° C., and of 1863 − 31·6°, a difference accordingly of almost 23°—an almost inconceivable variableness to us West-Europeans; being, for instance, nearly as great as the difference between the coldest winter month and the warmest summer month at Copenhagen within the same period. The observations referred to also exhibited the most remarkable instances of daily variations. In February, 1860, the thermometer rose on three different occasions more than 25° C. in the course of twenty-four hours.

These singular and sudden rises of temperature almost always stand in connection with a veering of the wind to south-east and east. It may appear very surprising, that the temperature rises with the wind blowing from the high land in the interior of Greenland, which is covered with eternal snow and ice. We need not, therefore, be surprised that old authors have endeavoured to explain this phenomenon by supposed volcanoes in action, or even by a comparatively very mild climate in the interior of Greenland—an hypothesis which it is, however, quite impossible to maintain on meteorological grounds. For every continent in high latitudes must necessarily, from the radiation of heat, be colder in its interior than at the coast where the sea makes the climate milder.

A glance at the map shows that Greenland lies between regions of the earth where, especially in winter, the temperature is exceedingly different. "To the west and

[1] Abstract of a paper by Hoffmeyer in the Danish Geographical Society's *Journal*, Part I., translated from *Naturen* of June, 1877 (Christiania).

south-west there occurs at this season of the year in Labrador, the Hudson's Bay territories and the Arctic Archipelago, so great a fall of temperature, that the mean temperature of January sinks from $-20°$ to $-35°$ C.; to the east and south-east, on the contrary, the Gulf Stream, even in mid-winter, maintains the temperature in the Atlantic at from 0° to 5° C., so that the superincumbent air can scarcely be supposed in general to be cooled under the freezing-point. Lying between such opposite varieties of temperature, the climate of Greenland must necessarily be in a high degree dependent on the prevailing direction of the wind at every particular period; all winds from south by west to north-east may bring comparative cold, but east and south-east winds, on the contrary, heat, and this ought specially to hold good of the south-east wind, both because it comes from the warmest part of the neighbouring Atlantic Ocean, and also because it has the shortest way to travel over the ice-deserts of the interior to reach the western coast. The character of the winter in Greenland will therefore certainly depend on whether the south or the east wind has prevailed during the course of it."

These explanations go a great way indeed, but still are not altogether sufficient. "Thus, when at Jacobshavn, shortly before July, 9° C. of heat are recorded during a south-east storm, while the normal temperature is $-12°$ C.; this high temperature cannot be derived alone from the Atlantic nearest in the south-east to Greenland; for it is quite improbable that the air could have so high a temperature at this season, and even if it may be supposed to pass over Greenland in the short space of eight to ten hours, it must by the way suffer a greater or less cooling by contact with the cold ice masses. Indeed if we go down to South Greenland we will there, in the month of December, be able to observe over 14° C. of heat, a temperature which we cannot simultaneously find in the Atlantic much nearer than at the Azores, and it cannot be supposed that the air has travelled from these islands to Greenland with its temperature unchanged."

"There are also other properties, besides its high temperature, which specially characterise the south-east wind in Greenland. For it appears always to be very dry; the snow melts away from the low country without any running water being visible. The storm begins first on the mountain-tops, where the snow is seen whirling high in the air, and then it afterwards works itself down in the fiord valleys."

These relations drew the writer's thoughts to other regions of the earth. On the northern slopes of the Alps a stormy southerly wind sometimes begins to blow very suddenly, which, from the snow-covered summits, hurls itself with irresistible force through the valleys which lead towards the north, and throws the Alpine lakes into frightful commotion. This wind, which is named *Foehn*, has, although it comes from a snowy region, an unusual warmth and dryness. Prof. Dufour has shown that during a *Foehn* which raged during the 24th and 25th September, 1866, the temperature was 6° to 9° C. over the normal in northern Switzerland; indeed at the town of Zug, although it lies 440 metres above the level of the sea, the temperature was higher than it was at the same time both north and south of the Alps. The unusual heat and dryness of the Foehn is also shown by the circumstance that the boundary of the snow in the valleys is seen to have receded very considerably when the storm subsides; it is therefore called, on that account, "the great snow melter."

At the same time that the southerly wind is found as a warm and dry *Foehn* on the northern side of the Alps, there blows, on the other hand, on the southern slopes of the mountains a humid sirocco, generally accompanied by an enormous fall of snow.

Several years back Dr. Hann, of Vienna, solved this enigma in a highly satisfactory way.

We know that the pressure of the atmosphere decreases upwards; when, therefore, a mass of air is forced by any cause to raise itself from the surface of the earth to a certain height, it will be subjected to a constantly diminishing pressure, and will accordingly expand, but as every expansion is a work which is accompanied by a consumption of heat, the air is cooled as it rises. As long as the cooling is not greater than that the air can retain its watery vapour, the heat will, according to calculations which have been confirmed by observations, diminish almost exactly 1° C. for every 100 metres the air rises. On the other hand, if the dew-point is exceeded, so that the watery vapour forms clouds, rain, or snow, the moisture will pass from the form of vapour to the fluid or solid state, whereby the combined heat is set free. The cooling from this moment proceeds much more slowly, and it may, within the limits of which we have experience, be stated as about ½° C. for every 100 metres.

When a mass of air, on the contrary, sinks towards the surface of the earth, it comes under higher pressure, is compressed, and consequently heated. Its temperature will rise more and more above the dew-point, and moisture will, with continually increasing ease, be held dissolved in the state of vapour. The heating during the whole descent will be 1° C. for every 100 metres.

These physical laws explain the properties of the *Foehn*. The air comes from the Mediterranean saturated with moisture, and passes over the summits of the Alps.

"Leaving out of consideration the cooling which goes on by the way, partly by radiation, partly by contact with mountain masses, a simple calculation will give the result that the temperature of a south wind will be about as many half degrees Centigrade higher at the north foot of the Alps than at the south foot, as the height of the mountain chain contains hectometres, for it is lowered half a degree for every 100 metres ascent, but raised one degree for every 100 metres descent."

These phenomena repeat themselves on Greenland. The writer sketches in detail a *Foehn* period which lasted eighteen to twenty days in the end of November and beginning of December, 1875. Jacobshavn was then for quite eight days warmer than North Italy. Upernivik, which lies about 10° to the south of the English North Pole Expedition's wintering station, was during the darkness of the Polar night warmer than the south of France. Unfortunately all direct observations from the uninhabited east coast of Greenland and the nearest parts of the Atlantic are wanting; but it may, however, be shown that during the period referred to a strong south-east wind blew from the sea over the land. For the so-called Buys-Ballot law in its simplest form teaches that the wind always blows so that it has the greater pressure of the atmosphere on its right, and that the more unequally the pressure is distributed the greater is the velocity of the wind. Now just during the days in question the barometer was much higher in Iceland than at Davis Straits. Over the tract lying between these places there had thus prevailed a strong south-east wind.

NOTES

OUT of above ninety candidates, Mr. James Edward Henry Gordon, B.A., of Caius College, Cambridge, has been selected by the Council of the British Association to be recommended to the Association as Mr. Griffith's successor in the important position of Assistant Secretary.

THE fiftieth *Versammlung deutscher Naturforscher und Aerzte* takes place at Munich on September 18–22. The following is the general programme:—Sept. 17, evening: Social gathering in the large saloon of the Rathhaus. 18: General session in the Odeon; address of welcome from Dr. v. Pettenhofer, addresses by Prof. Waldeyer, of Strassburg, on "C. v. Baer and his

Importance in the History of Evolution," and by Prof. Häckel, of Jena, on "The Present Theory of Evolution in its Relations to General Science." 19: Sessions of the sections. 20: General session; addresses by Prof. Tschermak, of Vienna, on "The Early History of the Earth;" by Prof. Klebs, of Prague, on "The Changes in Medical Theories during the Last Decade;" and by Dr. Neumayer, of Hamburg, on "The Relations of Meteorology to Every-day Life." Afternoon: Visits to the scientific collections. Evening: "Kellerfest." 21: Sessions of the sections. 22: Addresses by Dr. Avé Lallemant, of Lübeck, on "Animal Life on the Amazon;" by Prof. Günther, of Ansbach, on "The Latest Researches in the Mathematico-Historical Department;" and by Prof. Virchow, of Berlin. Expedition to the Stornbürger See.

THE forty-fifth annual meeting of the British Medical Association was opened on Tuesday at Manchester. A general meeting was held in the concert-hall, when the president, Dr. de Bartolome, of Sheffield, delivered an address. Dr. Wilkinson, of Manchester, was elected president for the ensuing year. In the evening a reception by the president of the Association and the Senate and Council of Owens College took place at that institution.

THE annual congress of the Royal Archæological Society of Great Britain and Ireland was opened at Hereford on Tuesday. After a public reception in the library and the presentation of a congratulatory address, the Bishop of Hereford, the local president, formally opened the proceedings. Sir Gilbert Scott delivered a lecture on the cathedral, and afterwards, in the cathedral itself, a historical and architectural description of the fabric. On the same day the annual meeting of the Cambrian Archæological Association was opened at Carnarvon, under the presidency of Lord Clarence Paget. The inaugural address was delivered by Prof. Babbington, who dwelt on the great advance of archæological science in North and South Wales. The Bishop of St. Asaph was elected president for the ensuing year, and the Hon. J. G. Wynn, hon. secretary for North Wales.

As we announced some weeks ago, the fifth periodical international Congress of the Medical Sciences takes place in Geneva on the 9th to the 15th September proximo. Among other subjects to be treated, we note:—Influence of alcohol on mental disease, influence of immigration from the country to towns, tuberculosis on the mountains and the Mediterranean coast, physical characters of the electric discharge of the torpedo, cerebral localisations, cause of sleep, functions of the spleen, physiological antagonism.

THE German Anthropological Society holds its eighth annual congress at Constance on September 26.

THE death is announced of Mr. Robert Were Fox, F.R.S., of Falmouth, in his eighty-eighth year. Mr. Fox is known as the author of various observations, especially in connection with geology and mining. Early in the century he made important observations on the ratio of the decrease of temperature in the earth, and at a later period published various papers in connection with magnetism and electricity. Mr. Fox was widely known among men of science, and universally respected.

THE honour of knighthood is to be conferred on Vice-Admiral Erasmus Ommanney, C.B., F.R.S., Vice-Admiral Edward Augustus Inglefield, C.B., F.R.S., and Rear-Admiral George Henry Richards, C.B., F.R.S., the late Hydrographer to the Admiralty.

A NUMBER of German scientific men have united to form a committee for the purpose of collecting a sufficient sum to erect a statue of the lately deceased botanist, Alexander Broun.

IN the House of Commons, on Tuesday, Mr. A. Egerton stated that the papers relating to the transit of Venus were in the hands of the printers, and he hoped that it would not be very long before they were in the hands of members.

IN connection with Capt. Howgate's proposed polar colony, a preliminary expedition in the U.S. schooner *Florence* was to start from New London on July 25, under the command of Capt. Tyson, of the *Polaris*. The object of the expedition is to engage a dozen Esquimaux families to be conveyed to Robeson Straits by the colonial expedition, to purchase dogs, native sledges, and a supply of clothing. The place of meeting appointed is Disco, where the colonists from America, it is hoped, will arrive early next spring.

A LETTER has been received by Dr. G. Bennett (now in London) from Signor D'Albertis, dated Somerset, Northern Australia, May, 2, 1877, in which he says, "I am ready to start for the Fly River, New Guinea, and intend to leave in the steam launch *Neva* to-morrow morning, if the weather is fine. My crew consists of five Chinese, three South Sea Islanders, and an engineer. I shall write to you whenever I have an opportunity."

FROM July 1 to July 14 a Dutch pilot schooner, which was fitted out for the purpose, made a short cruise through the North Sea, having on board five gentlemen, all members of the Netherlands Zoological Society, who completed a series of about forty dredgings in different localities. Heligoland was the farthest point reached in a northern and eastern direction. There seems to be good reason to be satisfied with the results which at this moment are being worked out at the Zoological Summer Station erected at Flushing for the season of 1877. That youthful establishment was represented on board by three of its committee members, Drs. Horst, Hoek, and Hubrecht. The vessel had been put at their disposal by government.

THERE will be arranged at Havre on the occasion of the forthcoming session of the French Association for the Advancement of Science, an Archæological and Geological Exhibition of Normandy. It will be divided into six sections, one of them relating exclusively to prehistoric ages.

DR. SACHS, who was sent to Venezuela by the Berlin Academy of Sciences, for the purpose of studying the electric eel in its native haunts, and whose progress we have already chronicled, has now returned, after an absence of ten months, with a rich store of valuable observations, which will shortly be laid before the academy.

PROF. FREDRICK WAHLGREN, who has occupied the chair of zoology for twenty years in the University of Lund, died during the past month in his fifty-eighth year.

THE Dutch Geographical Society has received a report from the expedition recently sent out to explore Sumatra. One division left Padary in the middle of May for the mountainous centre of the island. They have successfully penetrated into these hitherto unknown regions, and describe them as of surpassing grandeur. The mountain sides are clothed to the very top with a most luxuriant forest growth, almost impenetrable to the sun's rays. The inhabitants consist of a few utterly degraded Malays gathered together in wretched villages. The health of the expedition is excellent.

PETERMANN'S *Mittheilungen* for August, contains an important article, with map, by Dr. Schunke, on the navigable water-ways of Germany, with special reference to the canals. Dr. Polakowsky's paper on the vegetation of Costa Rica is continued, and accompanying a large-scale chart is an account of the examination of the mouth of the Congo by Commander Medlicott and Lieut. Flood in 1875. Nearly one half of the number is occupied with Behm's monthly *résumé* of Geographical news, now one of the most important features in this valuable journal.

News has been received in Europe of an eruption of the volcano Cotopaxi, near Quito. An immense quantity of ashes was ejected, principally in the directon of Guayaquil, falling on board ships sailing from Guayaquil to Panama. The distance was, in some instances, reckoned at 1,000 miles.

During the month of July an important series of longitudinal measurements have been carried out between the Bureau des Longitudes in Paris and the königliches geodötisches Institut in Berlin. The difference of longitude is now based on the mean of twelve carefully carried out observations. A series of observations between Paris and Bonn, and between Bonn and Berlin, which are to be undertaken during the present month, will act as a check on the work.

We have received a "Sketch Guide to the Industrial Museum of Glasgow," by Mr. James Paton, Superintendent of the Museum. As the museum is at present incomplete but rapidly filling up, the Guide is only a temporary one. It is compiled on a somewhat novel but instructive and intelligent plan.

Seydel and Co.'s hammocks, to which we referred in a recent number, have been awarded the gold medal for exellence at the International Horticultural Exhibition, Oporto.

We have received from the enterprising firm of Mawson and Swan, of Newcastle, specimens of magic pens which not only write without ink but in different colours. It is not necessary that we should state the many arguments advanced to prove their vast superiority over those used at present, but it is very clear that they will be very useful to travellers whether the arguments in question are sound or otherwise.

At a recent meeting of the Paris Geographical Society a letter from M. C. Wiener, who is travelling in South America at the expense of the French Government, was read, describing his ascent, on May 19, of Mount Illimani, whose height he makes out to be 20,112 feet. M. Wiener reached the summit, which he named Pic de Paris. Mr. Minchin, however, a railway engineer, who has been taking careful measurements of some of the South American peaks, gives the height of Illimani as 21,224, Wiener's figure being obtained by aneroid and boiling water.

A movement is on foot for a union of the natural history societies in the Midland District on a similar basis to that which has worked so well in the case of the West Riding Consolidated Naturalists' Society. A number of societies, representing nearly a thousand members, have given their adhesion to the movement, and a meeting is to be held at the Birmingham Midland Institute on August 28 to discuss the programme of the union, the journal, and other matters.

The pupils of the Parisian schools, who have obtained prizes in their respective classes, are to be sent on a pleasure trip to the seaside, under the direction of several masters, who are instructed to give them lectures on the places they may be visiting. This idea has been formerly acted on, but is now being tried on an enlarged scale.

The Japanese Government have built, at their own expense, and through Japanese operatives, a war balloon. It has been tried successfully at Tokio, and will be sent to the southern army, which is directed against rebels. It is of thick silk, magnificently made, and will be inflated with pure hydrogen.

Parts 50 and 60, completing the fifth volume of Mr. H. E. Dresser's great work on "The Birds of Europe," have been issued; and as there is but one more volume to come we may look forward with confidence to the completion of the entire undertaking in the course of next year. The present issue contains sixteen plates which are fully equal in accuracy and colouring to any that have preceded them, the gulls and terns, of which eight species are here figured, being especially beautiful. A provisional index to the five volumes now finished shows that 471 species of birds have now been figured and described.

In the last number of the *Zoologische Garten* it is announced that a second specimen of *Archæopteryx lithographica* had been discovered. Twenty years have passed since the original and hitherto unique example of this wonderful bird of bygone days was obtained by Ernst Haeberlein in the quarries of Pappenheim, near Solenhofen. The second specimen, discovered in the same place and by the same observer, is said to be much more perfect than the first, and to possess the entire head—a knowledge of which is much wanted for the better understanding of the affinities of this extraordinary organism.

The electrical illumination of the Lyons railway station is being completed. They are now using twelve electric lamps. This number will be enlarged successively to twenty-four lamps, fed with one light-producing and one light-distributing machine. It is believed that twenty-two horse-power will give a power of 2,400 gas-lamps, using 100 litres each per hour.

In a little official guide-book to the Rothesay Royal Aquarium, Mr. Barker, the curator, has brought together, in a popular and attractive form (for non-visitors as well as visitors), a good deal of useful information about the various fishes. The example is worthy of imitation.

The news of the discovery of a perfect mammoth in Tomsk is false. M. Polyakoff sent immediately by the St. Petersburg Academy, writes that he found only a large piece of mammoth flesh with skin and hair.

We notice in the *Memoirs* of the St. Petersburg Academy, vol. xix., an interesting Russian paper by M. S. Lopatin, "Some Notes on the Ice-sheets in the Rocks of Eastern Siberia." The paper is the result of widely-extended observations made by the author during his numerous travels in Eastern Siberia (basin of Vitim, lower Yenissei, government Krasnoyarsk, &c.), and on the Sakhalin Island.

The report of Dr. Schomburgk on the "Progress and Condition of the Botanic Garden and Government Plantations" at Adelaide, for 1876, has this year a similar feature to that of the recently-noticed report of Kew, inasmuch as it is illustrated; but in the case of that of Adelaide, with eight photographic views of different parts of the garden, external and internal views of the new palm-house, &c.; and a full description of this building is given. With regard to the prosperity of the garden, the greatest enemy, Dr. Schomburgk tells us, that it has had to contend with has been a very severe frost. The lowest temperature during the month of July was 28° Fahr., the lowest, indeed, ever experienced in Australia by Dr. Schomburgk. As might be imagined these severe frosts had a most disastrous effect upon most of the tropical plants, more especially on species of *Ficus*, many of which suffered so much that they were compelled to be cut down to two-thirds of their size, so that it will be years before they assume their former beauty, if ever they do. The frost made itself felt even in the glass-houses, and blackened the leaves of the plants standing near the glass, and the fountain basins were all covered with ice. Amongst useful plants which have occupied the attention of Dr. Schomburgk, the madder (*Rubia tinctorum*) seems to be amongst the most successful, so far as its rate of growth is concerned. It is stated to grow so vigorously about Adelaide that, "if not checked, it will become a nuisance, spreading everywhere." Its value is stated to be very great as a dye, and worth while cultivating, but we are under the impression that the aniline dyes have, to a great extent, and are still, indeed, driving madder out of the market. Attention will, no doubt, be centred upon other and more profitable plants. With regard to the routine work of the gardens, that is the distribution of seeds and plants, it does not compare badly with botanic gardens of greater pretension, for we learn that nineteen Wardian cases were dispatched during the year, containing about 800 stove and greenhouse plants, besides which 1,500 packets of seeds were also distributed to all parts of the world.

THERE is in the valley of the Maota in Switzerland, a grotto penetrating the mountain, and called the *Lauiloch*. It had not been explored beyond the Gorge du Loup, but recently some venturesome young people of Illgau have traversed this passage, and have penetrated, it is said, two whole leagues into the mountains, crossing various cavities where human foot had never trod before. They came at last to a deep fissure, which they could not explore, being without cords or ladders. A society has been formed for further exploration of the region, and the results will be published shortly.

IN a paper recently read to the Franklin Institute, Prof. Ennis gives the excellent advice to teachers that every day when the last half-hour of school-time arrives, the pupils should take their seats closely in front of the teacher's table, and he should then perform some scientific experiment, or exhibit some object of natural history, and tell all that can well be told about it. The pupils will make the more rapid progress in all their primary studies in consequence. The enjoyment of these scientific lectures is like dessert after dinner.

A PECULIAR kind of industry, that of breeding maggots, has lately been tried in Paris. Over the soil were spread large quantities of stale fish, dead lobsters, odorous poultry, and other refuse of the markets, as much as half a ton of large fish being taken on the premises in a single day. The maggots, which soon became abundant, were carefully picked out and packed in casks of galvanised iron, and finally were sold for fish bait and chicken food. The remaining refuse was converted into manure. Proximity to such an establishment could not have been very pleasant, and exposed provisions in the neighbourhood suffered largely from the visits of numberless flies. The police stepped in and suppressed the manufacture.

THE inhabitants of the Upper Engadine, one of the most attractive sites in Switzerland, have passed an order forbidding to sell or destroy a local wild-flower, which is called *Edelweiss*, and well-known to botanists. The destruction was so active that *Edelweiss* was fast disappearing.

THE three-yearly session of the International Congress for measuring the figure of the earth will take place at Stuttgart in the last days of September, under the presidency of Gen. Hanez, a Spaniard. The vice-president is Prof. Bauernfeind, late director of Munich Polytechnic School. It is said that France for the first time will join the Congress, and will be represented by Capt. Mouchez and Lœwy, two members of the Bureau des Longitudes.

THE following list of candidates successful in the competition for the Whitworth Scholarships, 1877, has been published by the Science and Art Department. William I. Last, Mechanical Engineer; F. Ogden, Mechanic; W. F. How, Engineer; W. S. M'Kenzie, Engineer; A. D. Ottewell, Draughtsman; D. A. Low, Engineer.

THE laboratories of the experimental farm at Vincennes, belonging to the French National School of Agriculture, were inaugurated the other day by the Minister of Public Instruction of the French Republic.

THE *Report* of the Royal Society of Tasmania contains among other papers of interest several important papers on Tasmanian shells by the Rev. J. E. Tenison-Woods.

THE bones of the bird hitherto known as *Tithornis emuinus* recently found at Sheppey, have enabled Prof. Owen to conclude that it was one with enormous wings, closely allied to, and much larger than, the albatross. The Professor, who has a paper on the subject in preparation, proposes to substitute a more appropriate name than the one given by Bowerbank. The bones are in the private collection of Mr. W. H. Shrubsole, of Sheerness-on-Sea, by whom they were found.

PROF. LANGLEY contributes to the *American Journal of Science and Arts* for July, an interesting paper "On the possibility of transit observations without personal errors."

THE Committee Report on the annual prize distribution of the French Société de Geographie appears in the Society's *Bulletin* for June. The recipients (to whom medals, &c., were awarded in April) are Lieut. Cameron, M. Roudaire, MM. de Folin and Leon Perrier, and M. Gravier; an account is given of the work of these investigators.

WE notice the appearance of a most interesting Russian work in the *Bulletin* of the Moscow Society of Friends of Natural Science, being a "Description of the various Zoological Gardens of Europe." The work is a collection of reports upon the most important zoological gardens, made by zoologists specially sent for that purpose, during 1876, by the Society above mentioned and by the Society of Acclimatisation, in order to find the best scheme for the organisation of the Zoological Gardens of Moscow. The introduction to the work is written by Prof. Bogdanoff.

THE additions to the Zoological Society's Gardens during the past week include a Grivet Monkey (*Cercopithecus griseo-viridis* from Africa, presented by Mr. J. Harvey; a Weeper Capuchin (*Cebus capucinus*) from Brazil, presented by Mrs. Cameron; a Wood Brocket (*Cervus nemorivagus*) from Caura, presented by Mr. C. C. Berington; an Oil Bird (*Steatornis caripensis*) from Trinidad, presented by Mr. W. G. de Vœux; a White Goshawk (*Astur novæ hollandiæ*), a Berigora Hawk (*Hieracidea berigora*) from Australia, presented by Major Spicer; a Harpy Eagle (*Thrasaëtus harpyia*), a Great-billed Rhea (*Rhea macrorhyncha*) from South America, received in exchange; an Axis Deer (*Cervus axis*) born in the gardens.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

SCIENCE AT KING'S COLLEGE, LONDON.—We understand that the Council of King's College have established a Science Course, including those subjects which, according to the new regulations, are required of candidates for the First B.Sc. or for the Preliminary Science Examinations of the University of London. Candidates for the Indian Civil Service, for the Home Civil Service, for the Indian Public Works Department, for the Royal Military Academy at Woolwich, and for other public examinations, will find in the course the scientific subjects which are required for those examinations. The course of study is under the direction of Prof. W. G. Adams. In addition to teaching and lectures in the several subjects, there will be included in the course Demonstrations and Practical work in the Physical, the Chemical, and the Biological Laboratories. The subjects for first year students in this course will be Mathematics, Elementary Mechanics, Physics, Chemistry, Zoology, and Botany, with practical work in each of the three laboratories. The second year's course will include these subjects with Geology.

EDINBURGH.—The Summer Session has just closed. In point of numbers the session 1876-77 has been the most prosperous the university has ever enjoyed, there being no fewer than

2,350 matriculated students. Last year the number was 2,065. The classes have consequently been large; especially is this true of the medical classes. For instance, the class of anatomy had 500 students on its roll. Sir Wyville Thomson's lectures were attended by upwards of 400 students; and Prof. Balfour had close upon 400 students in his class.

Prof. Lister has given his last lecture. At the close, Dr. J. B. Balfour in name of his fellow-students, expressed their regret at losing Mr. Lister, but at the same time honoured the motives which had led him to make the change, and wished him all success in the new sphere of work. Prof. Lister in replying said he felt very much gratified to find that his motives had not been misconstrued, and that so many of the students showed by their presence that they attributed his leaving them to a sense of duty. He thanked them for being so courteous and attentive, and appreciative of his efforts to teach, and wished them all happiness and prosperity.

TAUNTON COLLEGE SCHOOL.—Sixteenth and twenty-third in this year's list of successful candidates for Cooper's Hill are Messrs. Salter and Woollcombe, from the Taunton College School. This is an amusing commentary on the facts which we recorded some weeks ago.

BERLIN.—The magnificent new physiological laboratories are now nearly completed, and will be opened to students at the commencement of the winter semester. Prof. Dubois Raymond takes the directorship, and will be assisted by Prof. Kronecker, from Leipzig, and Prof. Baumann, from Strassburg, two of the more promising young physiological chemists of Germany. Prof. Helmholtz, who has been elected rector of the university for the coming year, will also take possession, during the coming autumn, of the spacious new physical laboratories which adjoin the physiological department.

MÜNSTER.—On July 19, the academic authorities laid the corner-stone of a spacious edifice which shall contain the lecture-rooms of the professors. The chemical laboratory of the newly-elected professor of chemistry, Dr. A. Oppenheim, is now nearly equipped, and will be opened to students during the coming autumn. It is reported that the Prussian Ministry of Public Instruction has the intention of supplying the lacking faculties of law and medicine, and of placing Münster on an equal basis with the other Prussian universities. The number of students at present is 300.

HEIDELBERG.—On July 27 the university authorities and students united in a festal celebration in honour of the twenty-fifth anniversary of the acceptance of a professorship in Heidelberg by Robert Wilhelm Bunsen. During the evening, one of those lengthy, picturesque, torchlight processions, so familiar to the residents of German university towns, led by gaily costumed marshalls, with gleaming swords, moved through the streets, to the residence of the veteran chemist, to extend to him the greeting of the students. Prof. Bunsen, who makes even shorter speeches than Gen. Grant, responded in a few modest words, accepting the honour more as a recognition of the offerings made by the university to the cause of science and especially of chemistry. The evening closed with the characteristic German *Commers*, in which ample tribute was paid to the eminent services of the great chemist in speech, poem, and song. Prof. Bunsen entered as a student at Göttingen fifty years ago. After six years of study there and at Paris, Vienna, and Berlin, he became privat-docent at Göttingen, then accepted, in 1836, a call to the Polytechnic of Cassel, as Wöhler's successor, removed in 1838 to Marburg, where he became in 1841 an ordinary professor, and from thence in 1851 to Breslau. In 1852 he followed a call to Heidelberg, where a new laboratory was built for him, and where he has remained despite many tempting offers from Berlin and other wealthier universities. His success as a teacher here has been unbounded, his laboratory and auditorium being full to overflowing, and the contingent of foreign students, from every quarter of the globe, being especially large. With the exception of his classical researches on cacodyl, and discovery of the antidotes for arsenious acid, most of Bunsen's more important discoveries occurred in the Heidelberg laboratory. These embrace researches on the absorption of gases, on diffusion, on the electrolytic preparation of metals, on photo-chemistry, on gasometric analysis, the invention of the magnesium light, the Bunsen lamp and galvanic element, &c. The most brilliant discovery of all still remains, that of spectral analysis, made in 1860 in company with Kirchhof, and leading to the immediate detection of cæsium and rubidium.

SCIENTIFIC SERIALS

THE current number of the *Journal of Anatomy and Physiology* commences with a paper by Drs. Lawes and Gilbert on the formation of fat in the animal body, in which from experiments on pigs it is shown most definitely that the amount of fat produced is not dependent on the amount of nitrogenous food ingested.—Dr. Ringer and Mr. Bury describe the influence of salacine on the healthy body with special reference to its influence on the temperature, in which it is demonstrated that the drug, like quinine, produces a slight depression for a brief period only.—Mr. T. W. Bridge writes on the cranial osteology of *Amia calva*, describing in detail the osseous elements of the skull, with a double plate illustrating it.—Prof. Rutherford and M. Vignal continue their account of experiments on the biliary secretion of the dog; the action of the sulphates of sodium, magnesium, potassium, phosphate, chloride, and bicarbonate of sodium, bicarbonate of potassium, chloride of ammonium, nitro-hydrochloric acid, and mercury are discussed.—Prof. Cleland describes a Sulu skull and gives suggestions for conducting craniological researches.—Mr. F. M. Balfour continues his valuable study of the development of elasmobranch fishes, completing the history of the primitive alimentary canal.—Mr. B. T. Lowne writes on the quantitative relation of light to sensation, as a contribution to the physiology of the retina.—Mr. W. H. Gaskell continues his observations on the vasomotor nerves of striated muscle, conducted in the laboratory of Trinity College, Cambridge, describing the normal circulation in muscle, the effects of section of the nerve, the effects of stimulating their ends, and the nature of vascular dilatation.

Reichert und Du Bois Reymond's Archiv, 1876, Part 4 (issued January, 1877).—J. Steiner, researches on the influence of temperature on the nerve and muscle current.—F. Boll on the structure of the electrical plates of torpedo.—G. Colasanti, anatomical and physiological researches on the arms of cephalopods.—E. A. Babuchin, further researches on electrical and pseudo-electric organs.

1876, Part 5.—H. Erler, on the relation between the exhalation of carbonic acid and the variation of animal temperature.—J. Hirschberg, dioptrics of the eye.—E. Dreher, on the theory of sight.

1876, Part 6 (issued April, 1877).—R. Hartman, contribution to the zoology and zootomy of the anthropoid apes.—H. Frey, on the vasomotor nerves of the extremities.—E. Hitzig, new researches on the brain.—W. Grüber, a series of papers on abnormalities of human anatomy.—G. Salomon, contribution to leukhæmia.

Zeitschrift für wissenschaftliche Zoologie, 1877, Parts 1 and 2 (in one).—F. E. Schulze, on the genus Halisarca, with five plates.—C. von Siebold, on the sexual development of urodele larvæ, referring especially to *Triton alpestris*.—F. de Filippi, on the larva of *Triton alpestris*.—A. Weismann, on the natural history of the Daphnidæ, parts 2, 3, and 4, 160 pp., with five plates.

Part 4.—H. Simroth, anatomy and fission of *Ophiactis virens*, 108 pp., four plates.—H. Dewitz, on the structure and development of the sting in ants.—L. Graff, on Neomenia and Chætoderma.—A. Brandt, on the frog's ovary, and the segmentation of the ovum.

Vol. 29, Part 1.—H. von Ihering, on the formation of ova in mollusca.—F. Vejdovsky, on the anatomy and metamorphosis of *Tracheliastes polycolpus* (parasitic copepod), three plates.—H. Ludwig, on the anatomy of *Rhizocochrinus lofotensis*.—F. E. Schulze, on sponges, part 3. Family Chondrosidæ.

Morphologisches Jahrbuch, vol. iii. Part 2.—H. von Ihering, on the nervous system of Amphineurida and Arthrocochlidæ (gastropods).—H. Strasser, on the air-sacs of birds.—E. Calberla, on the development of the spinal canal and cord in Teleosteans and Lampreys.—O. Hertwig, further contribution on the fertilisation and segmentation of the animal ovum.

Revue des Sciences Naturelles, vol. 6, June, 1877.—This number contains, in addition to its extended reviews of recent recent research in zoology, botany, and geology, articles on the classification of the animal kingdom, by A. Villot, on diatoms, by E. Guinard, on the cretaceous formation of Southern France, by M. Leymerie, and part of a catalogue of the terrestrial and fluviatile molluscs of the department of L'Hérault, by E. Dubrueil.

SOCIETIES AND ACADEMIES

VIENNA

Imperial Academy of Sciences, March 15.—The secretary presented the concluding parts (on Lepidoptera) of the work on the Novara expedition.—On the significance of Newton's construction of the order of colours of thin plates for the spectral investigation of the interference colours, by M. Rollett.—On the singularities of a conic-section system, by M. Igel.—On the development history of *equisetum*, by M. Tomaschek.—Medical observations, researches, and methods of cure, by M. Dyer.—Reciprocal linear surface systems, by M. Weyr.—Studies on the polypes and jelly fish of Trieste, by M. Claus.—Observations on the form and finer structure of the organ in the eel described as a testicle, by M. Frend.—On the central organ of the nerve system of Selachians, by M. Rohon.

May 11.—On the action of bromine on triamidophenol in presence of water, by MM. Weidel and Gruber.—A modification of Sauer's sulphur determination, by MM. Weidel and Schmidt.—On refraction and reflection of infinitely thin ray-systems on spherical surfaces, by M. Lippich.—On the discriminants of the Jacobi covariants, by M. Igel.—On the stationary flow of electricity in a plate, with use of straight electrodes, by M. Margules.—On the Turkish railways and their great economical importance, especially for Austria and Hungary, by M. Boué. He prophesies a great future for Salonica when the railway will be completed direct from the Danube along the Morava and from Vranja over Komanova to the Vardar railway. This will afford the shortest way from Austria to the Ægean Sea and the East.—On the influence of low temperatures on the life power of bacteria, by M. Fisch.—Contribution to the cryptogam flora of the Hawaiian peninsula, by M. Reichardt.—Theory and solution of irreducible transcendent equations, by M. Grossmann.

May 17.—On the inability of propylene to combine with water, by M. Linnemann. Even at 100° C. it unites neither with completely formed nor with nascent water.—Contributions to investigation of the phylogeny of plant species, by M. Ettingshausen.—On the normal surfaces to surfaces of the second order along a plane section of the same, by M. Koutny.—Production of corresponding points of two rational plane curves, by M. Zahradnik.—The northern light observations of the Austro-Hungarian Polar Expedition, 1872-4, by M. Weyprecht.—Free oblique projection, by M. Peschka.—Contributions to a knowledge of Phyllopoda, by H. Brauer.—Free temperature in its connection with external influences, by MM. Breitenlohner and Böhm.

June 7.—On an earthquake in Crete on the night of May 14, by M. Micksche. This is the most intense in the last three years. For forty-eight hours previously there was great calm in air and sea, and twenty-four hours after, violent thunderstorms occurred.—Observations on the origination of the cell-nucleus, by M. Stricker.—Small contributions to a knowledge of Annelidæ: I. The hypodermis of Lumbricidæ, by M. Mojsisovics.—On a method of determining the boiling point, by MM. Handl and Pribram.—Direct construction of the contours of rotation surfaces in general oblique projection, by M. Kuglmayr.—Theory and solution of irreducible transcendent equations with several unknown quantities and of higher order, by M. Grossmann.—On the distribution of fossil organisms in India, by M. Waagen. It is shown, *inter alia*, that the fresh-water formations extend far into the highlands towards the north-east.

PARIS

Academy of Sciences, July 30.—M. Peligot in the chair.—The following papers were read:—On the cosmic part of meteorology, by M. Faye. He throws doubt on the hypothesis connecting the sun-spots with magnetic variations, &c., on the one hand, and with actions of planets on the other, and assigns terrestrial causes for the variations.—Consequences to be drawn from experiments on the action of gases produced by dynamite, with regard to meteorites and the various circumstances of their arrival in the atmosphere, by M. Daubrée. The generic name of *Piezoglypt* is applied to the cavities produced in meteorites by the compressed gases. *Inter alia*, the fused external matter of the crust is easily carried, like sand and clay, towards the interior of the bolide, by the gas pressure outside. An extension of cupules over the large part of the surface indicates rotation of the meteorite.—Researches on the tertiary strata of Southern Europe, second part,—Tertiary strata of Vicentin, by MM. Hebert and Munier-Chalmas.—On an example of reduction of abelian integrals with elliptic functions, by Prof. Cayley.—Third note on the project of formation of a Saharan sea, by M. Cosson.—Organisation of the first scientific and hospital station of the International African Association, by M. de Lesseps. Arrangements have been made for establishing a depôt at Zanzibar, and an agency in Unyamwesi, so that the first station (under M. Crespel, accompanied by MM. Cambier and Maes) will be pretty far in the interior, perhaps on Lake Tanganyika, or further. M. Marno goes with the expedition as explorer.—Production of phylloxeric galls on the leaves of vine-stocks in the south of France, by M. Marès.—A message of sympathy was sent to M. Leverrier, who was stated to be getting better.—Observations on chemical equivalents, compared with corpuscular elements, by M. Baudrimont.—On a disease of the grape observed by M. Garcin, in the Narbonnese vineyards, by M. Macagno.—On the spectrum of the electric spark in gases submitted to increasing pressure, by M. Wüllner. Criticising a view wrongly attributed to him by M. Cazin, he distinguishes three modes of apparition of a continuous spectrum, according to the nature of the gas. The first (in hydrogen alone) is by diffusion of the spectral lines of the gas. In the second (in carbonised gases) a continuous spectrum appears between the lines, which finally disappear, without enlargement. In the third (*e.g.*, nitrogen and air), the lines continue visible and distinguishable with the continuous spectrum.—On the separation of iron from chromium and uranium, by M. Ditte. He recommends a similar treatment to that by which M. H. Sainte-Claire Deville separates alumina from iron.—On some properties of sulphides of platina from the analytic point of view, by M. Riban.—On a new mode of transformation of camphor into camphene, by M. de Montgolfier.—On some compounds of titanium, by MM. Wehrlin and Giraud.—Congenital ectopia of the heart; comparison of a graphic examination of the movements of the heart and cardiography in animals, by M. François-Franck.—On blood whose virulence resists the action of compressed oxygen and that of alcohol, by M. Bert. He is led to conclude that the blood in question contained not only *bactéridies* but septic vibrions whose corpuscular germs had this power of resistance, though the adult organisms succumbed to one or other of the two agents.—On the mechanism of deglutition, by M. Carlet. There is an interval (though very short) between the raising of the veil of the palate and the sudden ascent of the larynx.—On some points in the embryology of annelides, by M. Barrois.—A new type is here described, common at Roscoff in April.—On a new genus of the family of Tritoniades, by M. Vayssière. It differs exteriorly from *Dendroustus* only in the terminal part of its tentacles; but there are important internal peculiarities. The name Marionia (from Prof. Marion) is applied to it.—On the determination of potash, by M. Carnot. The special character of the new method described is isolation of potash at the very first, without precipitating the other bases. This is affirmed to economise time, and obviate a loss which is considerable where these bases are in dominant proportions.

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