THURSDAY, AUGUST, 12, 1880

ANCIENT GEOGRAPHY

A History of Ancient Geography among the Greeks and Romans from the Earliest Ages till the Fall of the Roman Empire. By E. H. Bunbury, F.R.G.S. With Twenty Illustrative Maps. Two Vols. (London: John Murray, 1879.)

THIS is one of that class of monumental and scholarly works which have almost died out in these days of multitudinous magazines and rapid publication, when authors have not patience to wait the completion of a work before they begin to publish. Mr. Bunbury's work is the task of a lifetime, and he well deserves the laurels bestowed upon him by the Geographical Society. It is both scholarly and scientific, the product of patient, wide, and thorough research, and treats a complicated subject with such completeness, clearness, and sound sense, that it is difficult to see how it can be supplemented or superseded. Much has been written on the subject of ancient, and especially classical geography, in Germany and France, and with all that has been written Mr. Bunbury is evidently familiar; his work, however, is in some respects superior to anything that has preceded it. His method is thoroughly scientific; he wastes but little space in endeavouring to extract a grain of sound geography from a bushel of legendary chaff, as so many of his pedantic predecessors have done. He weighs his evidence with rigid impartiality, is never content with second-hand authorities when the originals are attainable, and accepts no conclusions of previous writers unless led thereto by his own researches. He is thus compelled to reject much that has been hitherto accepted by those who have written on the subject.

Mr. Bunbury's book is no light reading. To do it justice requires long and patient study, and to review it fully and fairly would require the scope of a Quarterly. Every page bristles with learned notes, which cannot be passed over except at the risk of losing some important point in his well-knit narrative and close argument. Besides the foot-notes there are appendages of larger Notes to each chapter, in which disputed questions are discussed, and the scattered fruits of long research brought together. As the work is a History of Geography among the Greeks and Romans, the geographical knowledge of Egyptians, Jews, and Phœnicians is dismissed in a brief introduction. We should like to see Mr. Bunbury treat the geography of these two last interesting peoples in the same thorough manner as he has done that of the Greeks and Romans, and free it from the accretions of conjecture and fable that have encrusted it. Indeed it would be a matter of great interest if scholars as competent as Mr. Bunbury has shown himself to be in his own department would bring together for us in an equally compact and accessible form all that is known of the knowledge of geography possessed by all the old peoples who have left a literature. The Chinese especially, we believe, had a much more extensive knowledge of the geography, not only of Continental Asia, but of the Asiatic Archipelago, than any but a few special scholars have an idea of. It is a pity also that our Celtic and Teutonic forefathers had no permanent means of recording the tale of their wanderings westwards from their Asiatic fatherland; but surely the experiences they met with during these wanderings have left some impressions upon their extensive folk-lore. Still the first beginnings of solid geographical knowledge and theory rest with the Greeks and Romans, and even in a complete History of Ancient Geography everything must be made to centre in them.

Of course Mr. Bunbury in carrying out his weighty task is compelled to speak of the knowledge which those two peoples were likely to acquire from the nations with whom they came into contact, the Egyptians, the Carthaginians, the Persians, and the Indians. His discussion of the extent of the ancient Egyptian knowledge of the Nile and of the African interior is broad and interesting, and he shows a healthy scepticism as to the extent of the wanderings of the Phœnicians. This wholesome scepticism is a praiseworthy characteristic of his work throughout, from the Voyage of the Argonauts down to the Irish Annals. The Argonautic legend he dismisses as of really no geographical importance, but devotes considerable space to the geography of the Iliad and Odyssey. This he reduces to a very narrow compass of certainty, and dismisses as trivial the laboured attempts to identify the many names of places introduced into the Odyssean legend. Indeed the first certain knowledge of any countries beyond their own immediate shores came to the Greeks through the numerous colonies they founded, and even this scarcely extended beyond the environs of the settlements. The Greeks were doubtless enterprising enough in certain directions, but as a people they seem not to have been much given to exploration for its own sake. The knowledge of the regions beyond the confines of the Greek colonies on the Mediterranean and Euxine was for the most part extremely vague, consisting mainly of a multitude of names of tribes exceedingly difficult now to identify. They had for centuries the vaguest and most erroneous notions of the great physical features of Europe, Asia, and Africa, beyond the immediate neighbourhood of the shores of these continents; though by the time of Hecatæus of Miletus (520-500 B.C.) a wonderful amount of information had been accumulated in an unsystematic way. This knowledge had greatly increased and become more definite and accurate by the time of Herodotus in the next century. Mr. Bunbury's treatment of this large-minded and cautious historian is especially full and satisfactory, and betokens a vast amount of original research and full and accurate knowledge of the geography of the countries concerned. He clears away many erroneous opinions attributed to Herodotus, clearly proving by reference to the original that many statements attributed to Herodotus himself are really given by him as only second-hand reports to be received with caution. We all know how poor Livingstone met his death in a Quixotic search for the fountains in which the Nile was supposed to have its origin, an idea he attributed to Herodotus; but Mr. Bunbury shows clearly that the cautious historian held no such opinion himself, but merely related it as an incredulous story he had heard when in Egypt. With regard to the famous story of the circumnavigation of Africa by Necho, related by

Herodotus, Mr. Bunbury thinks it extremely improbable, but that it cannot be disproved.

Neither Greeks nor Romans, as we have said, troubled themselves much about exploration for its own sake; their geographical knowledge, which after the time of Herodotus accumulated at an increasing ratio, came to them mostly through their military expeditions. The wars of Alexander made vast additions to this knowledge, for he, like Cæsar, fond as he was of military glory, seems to have had a real love of acquiring a knowledge of new lands and peoples. Alexander brought within the sphere of fairly exact knowledge much of Western, Central, and Southern Asia, and the coast voyage, under his orders, of Nearchus from the Indus to the Persian Gulf is a landmark in ancient geography. Cæsar did for about one-half of Europe what Alexander did for Asia, and the merits of the former as an accurate observer are done ample justice to. The extension of the Roman Empire, begun under Cæsar, was continued by his successors, and how vast had been the strides in geographical knowledge during that period is shown by the careful and full examinations by Mr. Bunbury of the works of Strabo, Pliny, and Ptolemy.

Of the few genuine exploring expeditions of the ancient world Mr. Bunbury writes at length and with his usual caution and attention to accuracy and detail. The famous voyage of Hanno the Carthaginian, for example, along the west coast of Africa, about the end of the sixth or early part of the fifth century B.C., is done ample justice to, so far as the meagre records admit. This enterprise, when we consider the state of knowledge at the time and the means at the command of the leader, deserves all the praise that has been bestowed upon it. In a single voyage this daring navigator accomplished what the Portuguese of the fifteenth and sixteenth centuries took years to do. Mr. Bunbury is, we think, unusually successful in identifying most of the points named and clearing up the apparent difficulties in the brief existing account of this voyage that has come down to us; and there is no doubt that Hanno succeeded in reaching as far south as Sherboro, on the Sierra Leone coast, something like six degrees from the equator. Yet his example does not seem to have stimulated any one to complete his work. Pytheas is another well-known name in the history of ancient geography, and a name that should have a special interest for us, as he was the discoverer of Britain to the cultured nations of the period. (It is rather strange, by the by, that no enthusiastic geographer has ever suggested the appropriateness of erecting a monument to the venturous Massilian.) Mr. Bunbury rightly defends Pytheas from the attacks that have been made upon his veracity, and, as in the case of Herodotus, carefully distinguishes between what he states as the results of his own experience and the information he gives from the reports of others. It is not probable that he ever left the mainland of Scotland. Mr. Bunbury thinks it extremely difficult to identify the "Thule" of Pytheas, "six days voyage to the north of Britain;" he distinctly states that it belonged to the British group, which would certainly seem to exclude Iceland. Pytheas is well entitled to be considered a scientific observer; he added greatly to the knowledge which the Greeks had of tidal phenomena, and as might be expected was greatly struck with the astronomical phenomena of northern latitudes. Pytheas, moreover, as we know, set up a gnomon at his native town of Massilia, and thus determined the latitude of that place with a wonderful approach to accuracy.

Mr. Bunbury by no means devotes all his space to a record of the gradual extension of a knowledge of the earth's surface among the Greeks and Romans; he gives due attention to what is known as scientific geography, to the attempts of philosophers to discover the form and extent of the earth. At a comparatively early period it was conjectured that the shape of the earth must be spherical; by the time of Aristotle indeed it had become a generally received tenet among philosophers. Mr. Bunbury, however, considers Eratosthenes (born B.C. 276), the famous Alexandrine librarian, as the true parent of scientific geography; Strabo tells us that he made it the object of his special attention to "reform the map of the world" as it had existed down to his time, and to reconstruct it upon more scientific principles. "The materials at his command," Mr. Bunbury continues, "were still very imperfect, and the means of scientific observation were wanting to a degree which we can, at the present day, scarcely figure to ourselves; but the methods which he pursued were of a strictly scientific character, and his judgment was so sound that he proved in many instances to be better informed and more judicious in his references than geographers of two centuries later." Eratosthenes set himself to make a careful measure of the magnitude of the earth; his method was thoroughly scientific, though the data he had to start with were, as might be expected, by no means accurate. Under the circumstances the approximation he made to the measure of the earth's circumference was really wonderful. Mr. Bunbury's discussion of the method and results of Eratosthenes shows that he has mastered the scientific side of his subject as well as the historical; it is a fine example of careful and close reasoning. For an account of the work of Eratosthenes and other ancients in this direction we refer the reader to the series of articles on the Figure of the Earth in NATURE, vol. xviii. p. 356, *et seq.*

After all, even in the time of Ptolemy, the map of the world, after something like 800 years work, was of comparatively limited extent. Anything like accurate knowledge did not extend beyond Central and Southern Europe, Western and South-western Asia on the one side, and a small stretch of North Africa on the other. True a vague knowledge was on record of regions far beyond this, a knowledge however which had a vast amount of error mixed with a small modicum of truth. Still when we consider the limited means at the command of the Greeks and Romans, and that they had to overcome all the initial difficulties of the pursuit of knowledge, the results which they achieved are creditable to their enterprise.

Mr. Bunbury's history of these first beginnings of geographical exploration and geographical science is well worth a careful study, and will gain for him a high and permanent position in the literature of geography. Not the least valuable feature, we should say, are the numerous map illustrations of the progress of geographical knowledge at various periods.

THE MENHADEN

The Menhaden; being a History of the Fish. By G. Brown Goode. *With an Account of the Agricultural Uses of Fish.* By W. O. Atwater. (New York: Orange Judd Company, 1880.)

IN money value the American menhaden ranks fourth in the list of the fishes of the United States. First comes the cod, secondly the salmon, thirdly the mackerel, and then the menhaden. In absolute pounds' weight caught it would seem to come first of all, upwards of 460 millions of pounds' weight having been taken in 1876, whereas there was considerably less than half this weight of cod taken in that year, and all the salmon and mackerel taken if weighed together would not amount to much more than one-sixth of the weight. As its money value must depend on its economic value, it may be as well at once to briefly hint at its uses. As a table fish it is in favour in many parts of the United States, when perfectly fresh being considered superior in flavour to most of the common shore fishes. In the Washington fish market, when in season, they meet with a ready sale. Large quantities are salted, and there is a great export of these to the West Indies, where they serve as food for the negroes upon the plantations. Immense numbers are preserved in oil and spices and sold as sardines. Goodale's extract of fish is made out of menhaden, and the qualities of this preparation are testified to as being agreeable in flavour and decidedly nutritive as food for cattle. Menhaden scrap is a great success; sheep get rapidly fat on it. Hens, ducks, and turkeys prefer it to corn, and it need not be added that pigs greedily devour it. For bait it is extensively used in the cod and mackerel fisheries in New England and the British Provinces. Its popularity is no doubt chiefly due to the ease with which it may be obtained in quantity. As an article of commerce menhaden bait, it will be remembered, came under the consideration of the Halifax Commission of 1877; but perhaps even a greater future is open to the menhaden fisheries by the recently-established manufacture of oil and guano from these fish. The State of Maine claims to have been the first to discover its value, and now large factories turn out immense quantities of these materials. In 1874 from 50,000 to 75,000 gallons of oil was turned out from the Maine Works. The manufacture is simple in the extreme, consisting of three processes: boiling the fish, pressing and clarifying the expressed oil. The final operation is pumping it into immense bleaching tanks, where it becomes whiter and clearer in the rays of the sun. When well refined the oil is light-coloured, sweet, and of prime quality. The uses of this oil are manifold. It is chiefly employed, we are told, as a substitute for the more costly and popular oils, and to adulterate them. It is sold largely to tanneries for currying leather. The principal market for it is in Boston and New York, but considerable quantities are shipped to London, Liverpool, and Havre. But menhaden has still further uses. So far back in American history as 1621 we read that the Plymouth colonists learnt from an old Indian that they should use these fish as manure on their ground; and one Edward Johnson, writing in 1652, says, "But the Lord is pleased to provide for them [the New England colonists] great store of fish in the spring time. Many thousands of these they used to put under their Indian corn, which they plant in rills five foot asunder." Now as a result of the profitable utilisation of the menhaden for the manufacture of oil, the use of the whole fish as a fertiliser has gradually and almost entirely ceased, and the refuse from which the oil has been expressed is used instead. This is known as "fish-scrap" and "fish guano." In a wheat-growing country like North America the importance of the subject of artificial manures is great, and we quote from Prof. Cook's, of New Jersey, report to the State Board of Agriculture as follows: "Those who have tried a mixture of this fish guano with barn-yard manure and a little lime, say that it is superior to any guano in the market. When applied on corn the crop is considered as certain. The value of fish as manure is due mainly to the presence in it of nitrogen and phosphoric acid. The crops most assisted by fish manures are such as grass, grain, and corn, while leguminous crops, like clover, beans, and peas, are more benefited by mineral manures."

The above is but a brief *résumé* of one portion of Messrs. Goode and Atwater's interesting work, the title of which is quoted above. Their history was prepared for the Fifth Annual Report of the Commissioner of Fisheries for 1877. As reprinted, it forms an octavo volume of 540 pages and 30 plates.

The menhaden (*Clupea menhaden* of Mitchell) is, when adult, a most beautiful fish; its colour is pearly opalescent; each scale has all the beauty of a fine pearl, and the reflections from the mailed side of a fish just taken from the water are superb; the scales of the back and top of the head are of a purplish hue. Its importance to the States may be compared to the importance of the herring to Northern Europe. It is to be found at the same period during the year in the coast waters of all the Atlantic States from Maine to Florida. A surface temperature of about 51° is necessary for its appearance in waters near the shores. Its food is apparently for the most part minute algæ. The geographical range of the species, the arrival and departure of the "schools," the migration question, the peculiar movements of the "schools" of menhaden, are all subjects discussed at great length in this report, and from it many facts of great value to those interested in our own shore-fisheries are to be learnt.

The strange and unaccountable absence of the menhaden last year from the waters of Cape Cod are briefly alluded to in the Introduction. This absence was disastrous to many, and proved by a sad experience that the harvest of the sea will sometimes fail. The oil and guano factories lost a year's work; the factory hands and steamer's crew were entirely thrown out of employment; those were all on hand to begin work on June 1, and kept working, in the hope that the fish would "strike," until late in August. When they at last gave up all hope it was too late to engage in any other occupation to make money to carry them over the winter. This absence of the fish north of the Cape did not appear to be compensated for by any remarkable abundance in southern New England, but a much larger number of fish were captured in these waters in 1879, as so many more vessels went there to fish. We hope soon to hear of a good season's fishing at Cape Cod, and we strongly recommend this important report on the menhaden to the reader's notice.

OUR BOOK SHELF

Alphabetical Manual of Blowpipe Analysis. By Lieut.-Col. W. A. Ross. (London: Trübner and Co., 1880.)

Of late years the blowpipe has been very little used in practical chemistry. It has been felt that efficiency in qualitative analysis is not the final aim of the chemist; and this branch of chemical art has been more and more relegated to the position of an instrument for examination purposes.

There is however little doubt that a thorough training in qualitative analysis—such a course, for instance, as is furnished by Mr. Dittmar's manual—is of much service to the learner of chemistry; but even here the methods which are of most general application are founded on reactions "in the wet way."

The blowpipe, however, is beginning to reassert its claims to the favourable recognition of the chemical mineralogist. The little book in which Col. Ross condenses the results of his own and others' work is well calculated to advance these claims.

No regular course of analysis is given in this book beyond an outline of a method for classifying minerals for blowpipe examination, and an account of the Freiberg scheme of qualitative analysis of minerals. But under such headings as "Alloys," "Minerals," "Phosphoric Acid Reagent," &c., most useful information is presented to the worker in tabulated form. The table of "Reactions of ordinary Oxides at one View" is also useful.

Any mineralogist who has acquired some command of the blowpipe and has a fair elementary knowledge of chemistry must find this work of service to him; it contains in a small compass almost all that is required to be known in order to study the composition of minerals by "pyrological" reactions. Very many of the reactions described by Col. Ross are not to be found in other books. Not a few of his statements are opposed to generally-accepted facts. He gives a flat contradiction to the statement made in the text-books, that most metallic oxides are soluble in boric acid, or boron trioxide, at a red heat, whilst of course admitting their solubility in fusing borax; indeed he bases his system of blowpipe examination, or pyrology, to a large extent, on the non-solubility of metallic oxides in this reagent.

As is often the case with one who has undoubtedly advanced any branch of scientific work, Col. Ross is too ready to value his favourite method more highly than it deserves. Thus he is inclined to regard the blowpipe as "a more delicate analytical weapon than the spectroscope," and thinks that by its use he has proved that the production of D-lines is not always due to sodium!

U.S. Coast and Geodetic Survey. Pacific Coast Pilot. Coasts and Islands of Alaska. Appendix I. Meteorology and Bibliography. By W. H. Dall. (Washington, 1879.)

The complicated title of this large quarto volume gives very little idea of the nature and value of its contents. In the first sentence of the Letter of Transmission we meet with a new and amusing use of an old enough English phrase, when Mr. Dall coolly informs the superintendent of the Survey that he has "the honour to *turn in* the results of an inquiry into the meteorology of Alaska and the adjacent regions." The results of which Mr. Dall speaks in this irreverent manner must have cost him stupendous labour; indeed they might very well have taken years of research by a small international staff of inquirers. The publication comprises an abstract or summary of all accessible meteorological material relating to the district in question; both of that which has been published and is widely scattered through numerous proceedings, annuals, and transactions of learned societies, buried in periodicals in the Russian and other languages, and otherwise difficult of access; and also of a very large amount of unpublished material from the archives of the U.S. Coast Survey, the Medical Department of the U.S. Army, the U.S. Signal Service, and numerous contributions from private sources. With the abstracts are included the fullest references to the sources from which the materials are derived, and all the data which could be obtained as to the conditions of observation. The list of charts, maps, and publications relating to Alaska and the neighbouring regions, and occupying something like 200 quarto pages, is a wonderful piece of well-arranged work, and must prove valuable for many purposes besides that for which it has been immediately compiled. The volume also contains charts representing the monthly and annual means of temperature and pressure, graphic figures of the direction of the winds at each locality, and of the annual curves of pressure, precipitation, and temperature. Mr. Dall probably knows more about the region to which this volume refers than any other man living, and is able from his own observations and experience to contribute greatly to the value of his report. Altogether this is one of the most creditable of the many creditable scientific publications of the United States, and Mr. Dall is evidently one of the most valuable scientific servants of that Government. We hope, both for the good of the States and the interests of science, that he will be afforded every facility for utilising his exceptional ability as a scientific observer.

The Tree Planter. By Samuel Wood, Author of "Good Gardening."
The Tree Pruner. By the same Author. (London: Crosby Lockwood and Co., 1880.)

These two books form Nos. 209 and 210 of Weale's Rudimentary Series. Considering the numerous books Mr. Wood has written, the titles of which are set forth on the first pages of the little volumes before us, it is clear the author is suffering from a continued attack of *Cacoëthes scribendi.* Agreeing with the author, for the sake of argument, that there was a real necessity for the information he desires to impart, we cannot see why the matter contained in the two books should not have been combined in one, for the subjects of propagation and pruning are so closely associated that they would have gone better together rather than being separated; besides which a good deal of useless repetition would have been saved. Writing in the first book of what the author calls plants of the "Hibiscus Class—the *Althæa frutex,*" he says they are "deciduous shrubs of great beauty, comparable to carnations on trees." In the second book, under the head of "The Hibiscus," it is said—"These plants are among our most beautiful flowering shrubs; many of them will compare with the carnation." As an illustration of the author's method of imparting botanical knowledge, we will quote only two paragraphs from the article on the holly. He says—"There are a great many varieties of the holly, and nearly all of them are natives of Great Britain. There is also one commonly called *knee holly*, which is not a holly at all. The holly belongs to the natural order *Aquifoliaceæ*, while the knee holly, or *Ruscus aculeatus*, belongs to the natural order *Liliaceæ*, *i.e.*, flowers resembling a diminutive lily, while the flowers of the former belong to a class quite different, Linn. class 4, and order 3, the latter having 6 stamens and 1 style.

"Aquifoliaceæ conveys no idea of the class, but simply refers to the plant belonging to those with prickly leaves. This being the case, I am disposed to look upon the term 'Aquifoliaceæ' as misleading, because there are some other genera possessing prickly leaves, and some hollies that have leaves with no prickles, and in the case of the *Ruscus*, which has prickly leaves, it may be and is called a holly, while it is of another genus." It is impossible to comment on this. The author may be practical, but he is not scientific.

Tables for the Analysis of a Simple Salt. By A. Vinter, M.A. (London: Longmans and Co., 1880).

MANY tables for the qualitative analysis of simple salts already exist; another set is just added to the list by Mr. A. Vinter. It is very probable that students who—like those for whom Mr. Vinter's tables are arranged—can only devote one hour a week to practical chemistry, would do well to add that hour to those allotted to some other study; but if school-teachers will give their boys so insignificant a smattering of practical chemistry, these tables will, we think, be found useful and generally accurate so far as they go, which is certainly but a very little way indeed.

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 late Count L. F. de Pourtales

EVERY naturalist must have noticed with regret the news of the death of M. de Pourtales, of Cambridge, Mass., U.S., but those who have had the pleasure of his friendship and who have been fellow-labourers with him feel a most sincere sorrow at the loss which science has sustained.

The exploration of the deep sea brought Pourtales prominently before the scientific world, and his practical knowledge of the art of dredging not only produced results which were of great importance to Alexander Agassiz and Lyman, but they also provided him with a wonderful series of deep-sea corals, upon which he laboured with great success. The floor of the Gulf Stream in the Straits of Florida, the dredgings of the *Hassler* Expedition, and lastly, the examination of the results of the work done in the Caribbean Sea during the voyage of the U.S. steamer *Blake*, gave the opportunity, which was readily seized and utilised, of contributing largely and thoroughly to the knowledge of the interesting Madreporarian fauna of the depths. I can testify to the solid merit of the work done by my friend, and I can never forget his generous assistance, kindly criticisms, and desire to obtain the perfect truth. He spared no pains, and was ever at work in the difficult subject he especially chose; and he speedily grasped the relations of the past and present deep-sea coral faunas, and, besides adding largely to our knowledge of forms, contributed in a most important manner to the study of the generic and specific value of certain structures. Of his knowledge of the Crinoidea I need not write, but of the great value of the researches of the grave, courteous, and most genial man who is no longer amongst us I shall ever speak in terms of great admiration and gratitude.

Athenæum, August 8 P. MARTIN DUNCAN

The Recent Gas Explosion

ACCORDING to promise, I write to describe the continuation of the experiments on the above subject.

At present there is little else than failure to report, but as I am leaving home to-day and shall not be able to try any additional experiments for the next three or four weeks, I will merely mention the results obtained.

A piece of composition gas-pipe 10m. long, 15mm. internal diameter, and 2 mm. thick, was filled with a mixture of 2 vols. of hydrogen to 1 vol. of oxygen, and the gas exploded. The tube was not affected, the cork which closed it being projected.

It was then filled with a mixture of 10 volumes of coal-gas and 12 of oxygen, and in this case the tube withstood the explosion; a piece of india-rubber tube covered with calico tightly bound round it, which was used to connect the farther end of the tube to a metal stopcock, was however burst and the calico torn.

To-day I tried a tube made of paper. The tube is 7 mm. in diameter, and consists of eight layers of thin paper, stuck together with paste, and varnished on the outside with shellac.

This I have not succeeded in bursting with the mixture of hydrogen and oxygen; one of the caoutchouc stoppers which closed the glass tubes cemented to the end of the paper tube was blown off.

I hope to repeat the experiment with another paper tube which is not so strong. HERBERT MCLEOD

Cooper's Hill, August 9

Heat of the Comstock Lode

IN May, 1878, Mr. Church, who was at that time Professor of Mining at the University of Ohio, read a paper before the American Institute of Mining Engineers on the heat of the Comstock mines, which was subsequently, in an extended form, included in the author's volume on the Comstock lode, of which a review appeared in NATURE (vol. xxi. p. 511).

In this paper Mr. Church states that the temperature of the waters issuing from the mines worked upon the Comstock lode has always been somewhat high, but it was not until they had attained a very considerable depth below the surface that the workmen first became inconvenienced by extraordinary heat. At their present greatest depth (about 2,700 feet) water issues from the rock at a temperature of 157° F. (70° C.), and at least 4,200,000 tons of water are annually pumped from the workings at a temperature of 135° F. Mr. Church estimates that to elevate such a large volume of water from the mean temperature of the atmosphere to that which it attains in the mines would require 47,700 tons of coal. In addition to this, he calculates, 7,859 tons of coal would be required to supply the heat absorbed by the air passing along the various shafts and galleries through which it is diverted for the purposes of ventilation. It follows that to develop the total amount of heat necessary to raise the water and air circulating in these mines from the mean temperature of the atmosphere to that which they respectively attain, 55,560 tons of coal, or 97,700 cords of firewood would be annually required.

Mr. Church, in his paper, quotes four analyses of waters from the Comstock lode taken at different depths; these vary somewhat as to the relative proportions of the various substances present, but they contain on an average 42·62 grains of solid matter to the gallon. Of this amount 20·74 grains are calcic sulphate, 12·13 grains carbonate of potassium, 4·85 grains carbonate of sodium, and ·66 grain of chloride of sodium.

In order to ascertain approximately to what extent the production of the large amount of heat absorbed by the water may be ascribed to oxidation of sulphur and iron, the author first calculates the quantity which would be developed by the oxidation of pyrites equivalent to the calcic sulphate in solution. But having found that this amounts to only about $\frac{1}{18}$th part of that required, he seeks another solution for the difficulty, and without any calculations in support of the hypothesis, attributes this enormous development of heat to the kaolinisation of felspar in the subjacent rocks.

In a communication to the Geological Society of London, published in their *Quarterly Journal*, August 1879, entitled, "A Contribution to the History of Mineral Veins," I endeavoured to show that the kaolinisation of felspars is as inadequate to produce the effects observed as is the oxidation of pyrites, and a recent paper read by Mr. Church before the American Institute of Mining Engineers, as well as his letter on Subterranean Kaolinisation in last week's NATURE, have been written with a view of answering these objections.

In my communication to the Geological Society I applied to the kaolinisation of felspars a similar line of reasoning to that adopted by Mr. Church with regard to the oxidation of pyrites.

The average proportion of alkalies contained in the rocks of the district is 6·40 per cent., while the mean of the published analyses gives 11·30 grains of alkalies in the U. S. gallon of water. It follows that the 4,200,000 tons of water annually pumped out must contain 813 tons of alkalies, and that, as these are present in the rocks in the proportion of 6·40 per cent., the felspar in 12,703 tons of rock must be annually kaolinised and the alkalies removed in solution.

The amount of rock in which the felspar has been kaolinised being 12,703 tons, and the number of tons of water pumped out of the mines 4,200,000, it follows that $\frac{4,200,000}{12,700} = 330$ is the number of tons of water heated by each ton of completely altered rock.

In order, therefore, that one ton of rock should be enabled to heat 330 tons of water only 1° Fahr., and the specific heat of these rocks be taken at ·1477, that of blast-furnace slags, it would require to be heated by the kaolinisation of its felspar to a temperature above that of molten gold. Consequently to raise the water 85°, or to a temperature of 135°, at which it issues, the kaolinisation of the felspar in each ton of rock would require to elevate it to an extent it would be difficult to estimate.

To this Mr. Church, who derives his heat from the hydration of silicate of aluminium during the formation of kaolin, objects that the whole of the alkalies liberated by the decomposition of felspar do not become dissolved in water, and that their amount cannot consequently be taken as a measure of the quantities of that mineral which have been decomposed.

In support of this argument he states that clays from the immediate neighbourhood of the Comstock lode still contain above 4½ per cent. of alkalies, and ignores the fact that the final result of kaolinisation is the production of a hydrated silicate of aluminium free from alkalies. The clays in question must consequently be regarded as containing undecomposed felspar which cannot have contributed to any increase of temperature.

Admitting however for the sake of argument that all the felspar has been decomposed, and that three-fourths of the alkalies present have been retained by the resulting clay, the heat corresponding to the decomposition and hydration of the felspars in a ton of rock must be reduced by three-fourths. If, therefore, as before, to simplify our ideas, we regard the heat required to produce the observed effects as due to a single variation of temperature, the original temperature must have been above twenty times higher than the melting-point of gold, which appears as improbable as that found on the assumption of the whole of the alkalies entering into solution.

The assumption now made, namely, that much of the kaolinisation of the felspar is accomplished by aqueous vapour which is entirely absorbed by the rock, and which does not give rise to any aqueous solutions, involves conditions of which we have no known example, and of which it is difficult to conceive the existence at such great depths below the water-level of the country.

This view of the question was not advanced by Mr. Church in his original paper of 1878, and has probably occurred to him subsequently to the publication of my observations in the *Quarterly Journal of the Geological Society* in the following year. If however the possibility of such an alteration were admitted, it certainly could not be ascribed to kaolinisation, since the removal of the alkalies in felspars is an essential factor in that transformation.

With regard to the hot spring which formerly issued from between slate rocks and an elvan dyke at Wheal Clifford Mine in Cornwall containing notable quantities of chloride of lithium and other alkaline salts, cited by Mr. Church in his recent pamphlet in support of his views with respect to kaolinisation, the effect has probably been taken for the cause. Hot water is known to be a better solvent of mineral matter than cold water, and it has been shown by Daubrée that at high temperatures and under great pressure it is even capable of rapidly dissolving silica out of glass, and of leaving it in the form of crystallised quartz.

We have no direct evidence that the dissociation of the constituents of felspar and the subsequent hydration of the clay produced give rise to any liberation of heat. It is well known that the temperature of mines situated in granite, where kaolinisation is constantly going on, is lower than that of those worked in clay-slate, while high temperatures or thermal springs are not more frequently observed in masses of kaolinised granite than elsewhere.

The mines on the Comstock lode are situated in a highly-volcanic region of very late tertiary age, and in the almost immediate vicinity of lava-flows and boiling springs. Until, therefore, stronger evidence than that yet furnished shall have been brought forward, it is probable that the majority of geologists may continue to ascribe these phenomena to the action of volcanic agencies. J. ARTHUR PHILLIPS

18, Fopstone Road, Kensington, S.W., August 9

British Museum Attendants

As you are a free lance in British Museum matters, will you not make some remarks on the attendants? They are, as a body, intelligent and desirous of learning, but no attempts seem ever to be made to instruct them in the subjects of their departments; and all the information they possess is picked up by scraps, from overhearing the remarks of their chiefs to distinguished visitors.

Many of them do what they can to teach themselves; but why should they not have some regular training, and be competent to give simple and informal description-lectures to parties who really go for instruction? It cannot be said that it would imperil their charges by occupying their attention, when we see how a far scantier supply of care-takers completely guard South Kensington.

The object is not to get a higher paid and superior class of men, but to give them the advantages they might reasonably enjoy, and use them as rational beings. I have heard some of them deplore the way in which they are treated, "like so many watch-dogs"; the snuff-taking to keep awake; the lapses of the stouter ones into afternoon naps; the forbidden conversations, even on the objects of their care, with visitors; the reading of all the advertisements of the *Times*, for lack of better interest; all these are familiar subjects, as you will find if you once tap the flow of forbidden talk successfully.

Some attention to them might prevent such a colloquy as I once had with a flashy-looking fellow on one of the many unlabelled objects in his department. I asked, "Do you know where that squared block is from that stands on that terminal ornament?" Gallio (with a flower in his button-hole): "Which do you mean?" "That one which has another rough block standing on it." Gallio (impatiently): "Well! what about it?" "Do you know where it came from?" Gallio (with ineffable contempt): "No! indeed; I don't know where it's from. I don't know anything about it." If you should care to quote this, I can vouch for its accuracy, as I noted it at the time.

Bromley, Kent WM. FLINDERS PETRIE

Quassia and Mosquitos

IN NATURE, vol. xxii. p. 11, I read a letter in which the employment of a wash made from a decoction of quassia wood was recommended as a protection from the attacks of mosquitos and other insect pests. After reading the above-named letter I sent some of the quassia to my son, who is a surveyor camping out on the prairie in Dakotah Territory, U.S.A., in a part much infested in hot weather by mosquitos. In a recent letter my son states that he has repeatedly tried the wash with quassia, but without any beneficial results, the mosquitos having attacked him even before the solution had dried on his skin.

I have suggested that he should try carbolic acid ointment, if he can procure any, as English insects do not like the carbolic odour.

Possibly the mosquitos referred to in your correspondent's letter may have been much better fed than the North American tormentors.

If any of your numerous readers could communicate some effectual protection against the attacks of these pests, it would be a great boon to those who suffer so much from them.

Manchester, August 9 J. B. DANCER

Fascination

A VERY simple explanation may be offered of the seemingly mysterious facts of fascination, whether in man or the lower animals. Every one knows the old and ludicrous problem requiring us to decide what would happen to a hungry donkey placed at a spot exactly equidistant from two quite equally attractive bundles of hay. In theory the creature starves, being unable to make up its mind to choose one bundle rather than the other without any reason for such choice. In practice it is generally supposed that the unsteadiness of this world's affairs would speedily destroy the equilibrium of motives and leave the donkey free to make its meal of one or other of the bundles. But in critical emergencies, such as those mentioned in Mr. Curran's letter, when shot and shell are flying rapidly towards their victims, almost instantaneous decision is necessary. The circumstances are such that movement either to the right or to the left would be equally salutary and efficacious, but for the very reason that one movement would be just as good as the other, the mind makes its fatal pause of indecision. A man standing in the path of an advancing express train, and a small bird eyed by a snake, are probably affected both in the same manner. There need be no occult influence in the eye of the basilisk, as there can be no magical power in the iron and brass of the steam-engine, to transfix and fascinate the prey. Terror may no doubt in some instances paralyse the brain and make it incapable of choosing the method of escape, which to an intellect unembarrassed and free from panic would be the one obviously worthy of choice, but in the military examples cited by Mr. Curran it would be indecent to suggest such an explanation of the facts, and needless when the simpler solution is available.

Tunbridge Wells, August 9 THOMAS R. R. STEBBING

Strange Method of Crossing a Torrent

HAVING seen something very like, if not quite identical with, the following in the Himalayas, I am anxious to know if it is not a commoner device under similar conditions than is generally supposed everywhere. The story occurs in Gerard Boote's (Doctor of Physick) "Inland's Natural History," p. 59, and is related on the authority of "one Theophilus Buckworth, a Bishop of Dromore," in whose presence the feat was performed. His description of it runs as follows. After mentioning that the brook or river "that passeth by that town was greatly risen," he adds that "A country fellow who was travelling that way having stayed three days in hope that the water would fall, and seeing that the rain continued, grew impatient, and resolved to pass the brook whatever the danger was, but to do it with the less peril and the more steadiness he took a great heavy stone upon his shoulders, whose weight, giving him some firmness against the violence of the water, he passed the same without harm and came safe to the other side, to the wonderment of many people who had been looking on and given him up for a lost person." W. CURRAN

Warrington

Intellect in Brutes

NOT having seen any reference to Cowper's famous hares in any of the notices under this heading that have appeared in NATURE, I am induced to refer to them, the more so as the creature is rarely credited with much gratitude or intelligence. My information is from Tegg's edition of "The Life and Works of William Cowper," p. 633. Describing, at this place, the capers of his favourite hare named "Puss," who "would suffer me to take him up and to carry him about in my own arms," our poet adds that "he was ill three days, during which time I nursed him, kept him apart from his fellows, ... and by constant care, &c., restored him to perfect health. No creature could be more grateful than my patient after his recovery, a sentiment which he most significantly expressed by licking my hand, first the back of it, then the palm, then every finger separately, then between all the fingers, as if anxious to leave no part of it unsaluted; *a ceremony which he never performed but once again upon a similar occasion.* Finding him extremely tractable, I made it my custom to carry him always after breakfast into the garden. . . . . I had not long habituated him to this taste of liberty before he began to be impatient for the return of the time when he might enjoy it. He would invite me to the garden by drumming upon my knee and by a look of such expression as it was not possible to misinterpret. If this rhetoric did not immediately succeed, *he would take the skirt of my coat between his teeth and pull it with all his force.*" He "seemed to be happier in human society than when shut up with his natural companions," and if these traits do not *betoken* something more than instinct, it is hard to say where this ends and intellect begins.

Warrington W. CURRAN

Anchor-Ice

HAVING lately read with much interest several letters to NATURE on the subject of the formation of anchor- or ground-ice, I beg leave to inform your readers that it forms here every season in the Rock Island rapids of the Upper Mississippi River; any one desirous of studying its mode of formation would here have a good opportunity. Some observations of mine upon this phenomenon may be found in vol. ii. of the *Proceedings* of the Davenport Academy of Natural Sciences, p. 349.

Davenport, Iowa, U.S., July 10 R. J. FARQUHARSON

Depraved Taste in Animals

WHILE in Australia I kept at different times several koalas—all taken young. Of these three were inordinately fond of tobacco in any form. They would chew and swallow the strong Victorian black tobacco with the greatest gusto, and one, to which I gave a foul clay pipe saturated with tobacco oil, devoured the whole of the stem. Sitting on the nape of my neck, his usual place when I was writing or reading in the evening, "Ka-koo" would frequently stretch out one hand, take the pipe from my mouth, and begin to chew it if not promptly interfered with. During the day he passed most of his time rolled up on the rafters of the roof, bush houses being devoid of a ceiling, and on hearing the clinking of glasses, which betokened the preparation of the evening glass of grog, hurried down from his perch to receive his modest share of whisky and water. If a spoon were dipped in the raw spirit and given to him, he would take it in both his paws and lick it dry with manifest appreciation, and could only be prevented from making a raid upon every glass on the table by being tied with a handkerchief by the leg to the back of a chair. No ill effects ever followed these indulgences. ARTHUR NICOLS

THUNDERSTORMS[1]

WHEN I was asked to give this lecture I was also asked to give a short list of subjects from which your directors might select what they thought most fit. I named three. Regarded from the scientific point of view, one of them was to be considered as fully understood in principle, and requiring only additional experimental data to make it complete. This was the *Conduction of Heat in Solids.* Another was to a certain extent scientifically understood, but its theory was, and still is, in need of extended mathematical development. This was the popular scientific toy, the *Radiometer.* The third was, and remains, scarcely understood at all. Of course it was at once selected for to-night. I might have foreseen that it would be. You may well ask, then, why I am here. What can I say about a subject which I assert to be scarcely understood at all? A few years ago no qualified physicist would have ventured an opinion as to the nature of electricity. Magnetism had been (to a certain extent, at least) cleared up by an assumption that it depended on electric currents; and from Örsted and Ampère to Faraday and Thomson, a host of brilliant experimenters and mathematicians had grouped together in mutual interdependence the various branches of electrodynamics. But still the fundamental question remained unsolved, *What is electricity?* I remember Sir W. Thomson, eighteen years ago, saying to me, "Tell me what electricity is, and I'll tell you everything else." Well, strange as it may appear to you, I may now call upon him to fulfil his promise. And for good reason, as you shall see.

Science and Scotland have lately lost in Clerk-Maxwell one of their greatest sons. He was, however, much better known to science than to Scotland. One grand object which he kept before him through his whole scientific life was to reduce electric and magnetic phenomena to mere stresses and motions of the ethereal jelly. And there can be little doubt that he has securely laid the foundation of an electric theory—like the undulatory theory of light admirably simple in its fundamental assumptions, but, like it, requiring for its full development the utmost resources of mathematical analysis. It cannot but seem strange to the majority of you to be told that we know probably as much about the secret mechanism of electricity as we do about that of light, and that it is more than exceedingly probable that a ray of light is propagated by electric and electromagnetic disturbances. It is one of the most remarkable advances made during this century.

But to know what electricity is, does not necessarily guide us in the least degree to a notion of its source in any particular instance. We might know quite well *what* is electricity and yet be, as I told you at starting we *are*, almost entirely uncertain of the exact source of *atmospheric* electricity.

To come to my special subject. I am not going to try to describe a thunderstorm. First, because I am certain that I could not do it without running the risk of overdoing it, and thus becoming sensational instead of scientific; and secondly, because the phenomenon must be quite familiar, except perhaps in some of its more singular details, to every one of you.

Science has to deal with magnitudes which are very much larger or smaller than those which such words as huge, enormous, tiny, or minute are capable of expressing. And though an electric spark, even from our most

[1] Abstract of a lecture, delivered in the City Hall, Glasgow, by Prof. Tait.

powerful artificial sources, appears to the non-scientific trifling in comparison with a mile-long flash of lightning, the difference (huge, if you like to call it) is as nothing to others with which scientific men are constantly dealing. The nearest star is as much farther from us than is the sun, as the sun is farther from us than is London. The sun's distance is ninety-three millions of miles. If that distance be called enormous, and it certainly is so, what adjective have you for the star's distance? Ordinary human language, and especially the more poetic forms of it, were devised to fit human feelings and emotions, and not for scientific purposes. A thoroughly scientific account of a thunderstorm, if it were possible to give one, would certainly be at once ridiculed as pedantic.

Let us therefore, instead of attempting to discuss the phenomenon as a whole, consider separately some of its more prominent features. And first of all, what are these features when we are *in* the thunderstorm?

By far the most striking, at least if the thunderstorm come on during the day, is the extraordinary darkness. Sometimes at mid-day in summer the darkness becomes comparable with that at midnight, very different in kind as well as intensity from that produced by the densest fog. Objects are distinctly visible through it at distances of many miles, whether when self-luminous or when instantaneously lit up by lightning. The darkness, then, is simply intense *shadow*, produced by the great thickness and great lateral extension of the cloud-masses overhead. Seen from a distance, the mass of cloud belonging to the storm usually presents a most peculiar appearance, quite unlike any other form of cloud. It seems to boil up, as it were, from below, and to extend through miles of vertical height. The estimated height of its lower surface above the ground varies within very wide limits. Saussure has seen it as much as three miles; and in one case noticed by De l'Isle it may have been as much as five miles. On the other hand, at Pondicherry and Manilla it is scarcely ever more than half a mile. Haidinger gives the full details of an extraordinary case, in which the thundercloud formed a stratum of only twenty-five feet thick, raised thirty yards above the ground. Yet two people were killed on this occasion. Other notable instances of a similar extreme character are recorded.

Careful experiment shows us that the air is scarcely ever free from electricity, even in the clearest weather. And even on specially fine days, when large separate cumuli are floating along, each as it comes near produces a marked effect on the electrometer. Andrews obtained by means of a kite, on a fine clear day, a steady decomposition of water by the electricity collected by a fine wire twisted round the string. Thanks to Sir W. Thomson, we can now observe atmospheric electricity in a most satisfactory manner. I will test, to show you the mode of proceeding, the air inside and outside the hall. [The experiment was shown, and the external air gave *negative* indications.]

On several occasions I have found it almost impossible, even by giving extreme directive force to the instrument by means of magnets, to measure the atmospheric potential with such an electrometer, and had recourse to the old electroscope, with specially long and thick gold-leaves. On February 26th, 1874, when the sleet and hail, dashing against the cupola of my class-room, made so much noise as to completely interrupt my lecture, I connected that instrument with the water-dropper, and saw the gold-leaves discharge themselves against the sides every few seconds, sometimes with positive, sometimes, often immediately afterwards, with negative electricity. Such effects would have required for their production a battery of tens of thousands of cells. Yet there was neither lightning nor thunder, and the water was trickling from the can at the rate of only two and a half cubic inches per minute. Probably had there not been such a violent fall of sleet steadily discharging the clouds we should have had a severe thunderstorm. Falling rain-drops are often so strongly charged with electricity as to give a spark just before they touch the ground. This "luminous rain," as it has been called, is a phenomenon which has been over and over again seen by competent and trustworthy observers. In the *Comptes Rendus* for November last we read of the curious phenomenon of electrification of the observer's umbrella by a light fall of snow, to such an extent that he could draw sparks from it with his finger.

In calm clear weather the atmospheric charge is usually positive. This is very commonly attributed to evaporation of water, and I see no reason to doubt that the phenomena are closely connected. [A few drops of water were sprinkled on a heated crucible, insulated, and connected with the electrometer.]

There can be no doubt that, whatever be the hidden mechanism of this experiment, the steam has carried with it a strong charge of positive electricity, for it has left the rest of the apparatus with a strong negative charge. We will now try that form of the experiment in another way. [High-pressure steam escaping from a little boiler was made to play upon an insulated conductor furnished with spikes, and connected with the electrometer, which then showed a strong positive charge.]

There are many substances which produce on evaporation far greater electric developments than water does, some of positive, others of negative, electricity. By far the most remarkable in this respect to which attention has yet been called is an aqueous solution of sulphate of copper. (*Proc.* R.S.E., 1862.) The smallest drop of this solution thrown on a hot dish gives an intense negative effect—so great, in fact, that it may be occasionally employed to charge a small Leyden jar. But this, like the smaller effect due to water under similar circumstances, is not yet completely explained.

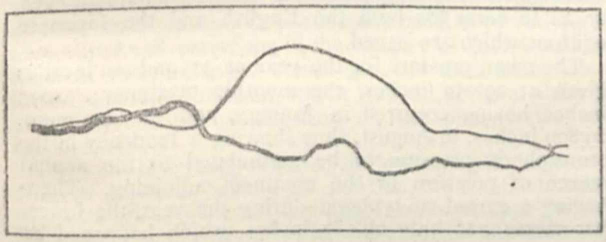
The next striking features are the flashes of lightning which at intervals light up the landscape with an intensity which must in the majority of cases far exceed that produced by the full moon. To the eye, indeed, the flash does not often appear to furnish more than the equivalent of average moonlight, but it must be remembered that it lasts for a period of time almost inconceivably short, and that the full effect of light on the eye is not produced until after the lapse of a considerable fraction of a second. Prof. Swan has estimated this interval at about one-tenth of a second; and he has proved that the apparent intensity of illumination for shorter intervals is nearly proportional to the duration. (*Trans.* R.S.E., 1849.) I can illustrate this in a very simple manner. [Two beams of light were thrown upon the screen by reflection from mirrors, each of which was fixed *nearly* at right angles to an axis. When matters were so adjusted that the brightness of the two illuminated spots was the same, one mirror was made to rotate. The corresponding light spot described a circle about the other, and its brightness became less the larger the circle in which it was made to revolve.] The lightning flash itself on this account, and for the farther reason that its whole apparent surface is exceedingly small, must be in some degree comparable with the sun in intrinsic brilliancy—though, of course, it cannot appear so. The fact that its duration is excessively short is easily verified in many ways, but most simply by observing a body in rapid motion. The spokes of the wheels of the most rapidly-moving carriage appear absolutely fixed when illuminated by its light alone. One can read by its light a printed page stuck on a disc revolving at great speed. But the most severe test is that of Sir Charles Wheatstone's revolving mirror. Seen by reflection in such a mirror, however fast it may be rotating, a flash of lightning is not perceptibly broadened, as it certainly would be if its duration were appreciable.

The apparatus which, in our laboratories, enables us to measure the time which light, moving at nearly 200,000 miles per second, takes to pass over a few feet, is *required* to prove to us that lightning is not absolutely instantaneous. Wheatstone has shown that it certainly lasts less than a millionth part of a second. Take this, along with Swan's datum, which I have just given you, and you see that the apparent brightness of the landscape, as lit up by a lightning flash, is *less than one hundred thousandth part* of what it would be were the lightning permanent. We have thus rough materials for instituting a comparison between the intrinsic brightness of lightning and of the sun.

Transient in the extreme as the phenomenon is, we can still, in virtue of the duration of visual impressions, form a tolerably accurate conception of the form of a flash; and in recent times instantaneous processes of photography have given us permanent records of it. These, when compared with photographic records of ordinary electric sparks, bear out to the full the convictions at once forced by appearances on the old electricians, that a flash of lightning is merely a very large electric spark. The peculiar zig-zag form, sometimes apparently almost doubling back on itself, the occasional bifurcations, and various other phenomena of a lightning flash, are all shown by the powerful sparks from an electric machine. [These sparks were exhibited directly; and then photographs of some of them were exhibited.]

The spectroscope has recently given us still more convincing evidence of their identity, if any such should be wanted.

The bifurcations of a flash can puzzle no one who is experimentally acquainted with electricity, but the zig-zag form is not quite so easily explained. It is certainly destroyed, in the case of short sparks, by heating the air. [Photographs of sparks in hot and in cold air were



exhibited. One of each kind is shown in the woodcut. The smoother is that which passed through the hot air. The other passed through the cold air nearer the camera, and is therefore not quite in focus.]

Now heating in a tube or flame not only gets rid of motes and other combustible materials but it also removes all traces of electrification from air. It is possible, then, that the zig-zag form of a lightning flash may, in certain cases at least, be due to local electrification, which would have the same sort of effect as heat in rarefying the air and making it a better conductor.

A remark is made very commonly in thunderstorms which, if correct, is obviously inconsistent with what I have said as to the extremely short duration of a flash. The eye could not possibly follow movements of such extraordinary rapidity. Hence it is clear that when people say they *saw* a flash go upwards to the clouds from the ground, or downwards from the clouds to the ground, they must be mistaken. The origin of the mistake seems to be a *subjective* one, viz., that the central parts of the retina are more sensitive, by practice, than the rest, and therefore that the portion of the flash which is seen directly affects the brain sooner than the rest. Hence a spectator looking towards *either* end of a flash very naturally fancies that end to be its starting-point.

(*To be continued.*)

OBSERVATIONS ON ARCTIC FOSSIL FLORAS WITH REGARD TO TEMPERATURE

THE first feelings of surprise caused by the discovery of remains of warmer-temperate, sub-tropical, and even tropical plants within the Arctic circle, of, geologically speaking, comparatively recent age, have now died away, and we no longer find that their presence there forms so favoured a theme for speculation. The time appears to have arrived when we may critically examine the botanical evidence upon which estimates of the past degree of warmth enjoyed by the Arctic regions have to be formed. The method open to us is very simple: we have, it seems, only to first set aside determinations that are clearly little more than guesses; then ascertain the minimum mean temperature required by the remaining groups of plants to flourish at the present day; and the sum of these temperatures should furnish reliable results for each period.

I am not yet able myself to carry this inquiry beyond the ferns and conifers, but the determinations of these are probably so very much more accurate than those of the higher orders of plants as to comprise most of the safer data, and they are sufficiently numerous for the purpose.

My present remarks are limited to the Komeschichten, a horizon supposed in the "Flora Fossilis Arctica," to represent in Greenland the Urgonian or Neocomian of Central Europe. In this Komeschichten two genera of ferns occur which deserve especial consideration, for Prof. Heer makes use of their presence to infer that at that period the Arctic regions were favoured with a sub-tropical or even tropical climate. These genera are *Gleichenia* and *Oleandra*. The correctness of the determination of the supposed Arctic Oleandra is doubtful, and it is best for the present to place them among the guesses. The very sparse indications of sori are not satisfactory, and there are no less than twelve widely-distinct genera possessing species with approximately the same venation. Oleandra is a small genus with but six species, almost confined to the tropics, but two of them grow in Northern India at altitudes of 6,000 and 7,000 feet.

It is quite otherwise with the remains of *Gleichenia*, for these preserve every characteristic of that genus. But while it is perfectly obvious that these are really fragments of Gleichenias, neither the number of species into which Prof. Heer has divided them, nor the inferences as to climate which he draws from them, can be admitted. He has quite unnecessarily, it seems to me, separated the fragments from the Komeschichten into fourteen species, and to these has added two from the Ataneschichten. The prevailing species, *G. Zippei*, if considered to represent the type in its average size, might be made to embrace eight or ten of them without even then approaching the limits of variation seen in the corresponding existing species. *G. Gieseckiana* receives the rather larger pinnæ and *G. gracilis* the smaller, and many others seem separated on trifling or fancied peculiarities, as *G. acutipennis*, which is merely a small, indistinct fragment, with a few rounded depressions, conjectured to mark sori, but which, from their position on the mid-rib, could not well be such. *Gleichenia* is a particularly variable fern. Berkeley mentions (Introd. to "Crypt. Bot.," p. 516, Fig. 110, *b*) that he had seen at Kew the minute pinnules of one of them expanded to three times its normal length, and the margins unfolded by exposure to a warm damp atmosphere. In two full-grown specimens of *G. dichotoma* from Khasia, in the Kew Herbarium, the longest pinnules respectively are one and nine centimetres in length. The Arctic species are, however, closely represented by *G. glauca* (*G. longissima*, Hook., "Syn. Filicum"), and in this species the pinnules in different plants vary, from a single locality, between 25 and 2 mm. in length. In making species out of fragments of fossil plants the greater or less liability of the living forms to vary should, it seems to me, be kept in mind, and for general convenience the greatest possible number, if from one locality and horizon, be included together.

There are not wanting altogether, however, indications of other species, and among them *G. rigida*, *G. rotula*, and *G. micromera* seem to be distinct, but the great majority are simply pectinato-pinnatifid, and possess no really distinctive specific characters. In addition to this, fourteen species from one locality and horizon appear a very unlikely number to have existed together, for although the plants are sociable and grow massed together, but few species are ever met with living together in the same vicinity. The whole of America, which is the richest continent in species, contains but nine, the varied lands grouped as the Malayan region but seven, New Zealand five, Australia four, &c.; the total number recognised by Hooker in the "Synopsis Filicum" being but twenty-three. The greatest number growing in a restricted area is in North Caledonia, where there are four; but I am not aware whether these are actually associated together.

These Gleichenias are repeatedly alluded to by Prof. Heer as indicating a tropical nature for the Arctic cretaceous flora, but so far as their presence goes, they by no means imply that a high temperature prevailed. Although no Gleichenia now ranges into high northern regions, they flourish south in the rigorous climates of the Magellan and Falkland Isles, S. lat. 53°, which have an isotherm of less than 45°, and are also found on the high mountains of Tasmania and on the Andes at 10,000 feet, which is, according to Humboldt, the level of gentians and near the limit of arborescent vegetation. The group of Gleichenias from the colder regions of South America all resemble each other in much the same degree as those of the Arctic regions did, and all possess small, hard, rigid, pectinato-pinnatifid pinnæ. Among them are *G. pedalis*, *G. cryptocarpa*, and *G. quadripartita*, all of which, but especially the former, vary considerably, being either long or shortly pectinate. It is a suggestive fact that the existing representative of these Arctic Gleichenias is the only one that still ranges into northern temperate regions, such as China and Japan, while the representative of the English Eocene species is an essentially tropical form.

The Arctic group of Gleichenia appears to have very little affinity with European fossil plants of similar age, except through *G. Zippei*. Heer connects one with *G. comptoniæfolia*, from Aix-la-Chapelle, although there is little discoverable resemblance between them. To do so he has to point out a discrepancy between the drawing and the description, and although he had never seen the specimens, prefers to rely on the drawing which Dr. De Bey now disclaims as incorrect. The Aix-la-Chapelle types are really quite different and more varied, and link them with our own eocene species. This latter is an essentially tropical type, and completely distinct from either the fossil Arctic group or the existing forms from the cold southern latitudes, since it closely approaches *G. dichotoma*, the only type of a well-defined section of the genus, now almost universally distributed over the tropical world.

The Gleichenias seem first to have appeared in the Jurassic, to have passed away from Europe before the close of the Eocene period, and to be now decidedly characteristic of the southern hemisphere—very few species crossing the equator, although the representative of the fossil Arctic species still extends as far north as Japan. It is obvious that we need not, from their presence, assign a very high mean annual temperature to the older cretaceous period in Greenland.

J. S. GARDNER

METEOROLOGY IN JAPAN

WE have read carefully and with great pleasure the *Memoirs* of the Science Department of the University of Tokio, Japan, vol. iii. Part i., which gives the report of the meteorology of Tokio for 1879, by Prof. T. C. Mendenhall. The observations, which are carried on in the west wing of the small observatory attached to the University, were commenced in January 1879, and this is the first report issued by the Observatory. The instruments are from Negretti and Zambra, and, with the exception of the thermometers, they appear to have been placed in suitable positions. The thermometers are mounted outside the north window of the second floor, and are separated from the observing room by glass doors, which are opened for observation. This position of the thermometer is in several respects objectionable, but particularly as it precludes any comparability, beyond a rough one, between the temperature observations at Tokio and at other stations which are or may be established in Japan.

The hours of observation are 7 a.m., 2 and 10 p.m., an arrangement of hours, it may be remarked, which states the mean temperature of the six warmest months of the year about three-fourths of a degree too high, and further does not approximate with the desired closeness to the important diurnal turning-points of the barometric pressure. It is however right to add that it is declared desirable to increase the number of the observations to at least five or six during the day as soon as the necessary arrangements can be made, and to institute a series of hourly observations for approximately determining several of the diurnal curves. An arrangement, if possible to be carried out, for the erection of continuously-recording instruments, would be an important gain to Japan meteorology.

The observations are published *in extenso*, and are illustrated with great fulness by excellent diagrams, which show in a clear manner the main results of the year's observations, the diagrams being lettered and numbered so as to serve for both the English and the Japanese editions which are issued.

The mean pressure for the year at 32° and sea level is given at 29·952 inches, the monthly maximum, 30·093 inches, having occurred in January, and the minimum, 29·809 inches, in August, thus showing a tendency in the atmospheric pressure to be assimilated to the annual march of pressure in the continent adjoining. There having occurred no typhoon during the year, the lowest barometer was only 29·087 inches, which happened on February 23, and the highest, 30·515 inches, on April 21, the range for the year thus being 1·426 inch. The mean diurnal range from 7 a.m. to 2 p.m. is large, being 0·059 inch for the year, regarding which Prof. Mendenhall remarks that "this same relation exists in each set of monthly means with two exceptions." These exceptions are May and September, the ranges for which being, as printed in the means, 0·028 inch and 0·019 inch. On comparing these ranges with those for the other months, they are at once seen to be physically impossible; but by averaging the observations themselves for these months these exceptionally low ranges turn out to be due solely to errors of computation. The true range given by the observations for May and September are 0·047 inch for each month. The exceptionally large range for July, viz., 0·085 inch, is also an error of computation; the true range was only 0·052 inch, the mean range at Tokio being, as in corresponding latitudes of the Atlantic, less in the summer than in the winter months.

The lowest temperature for the year was 24°·1 on January 2 and 7, and the highest 93°·0 on August 15. The temperature fell to or below freezing (32°) on 46 days, 27 of these days being in January, and rose to or above 90°·0 on 12 days, 7 of these days being in July and 5 in August. The mean annual temperature deduced from the 7 a.m., 2 and 10 p.m. observations was 58°·5, and from the maximum and minimum observations 58°·0, the higher temperature of the former being due to the 7 a.m. observations. If this were changed to 6 a.m. the hours of observation would then be equidistant, which would furnish data for a more exact determination of the mean temperature.

Perhaps the most interesting part of the Report is what relates to the wind which is discussed with no little ability and fulness. The results establish beyond doubt that the wind blows more frequently from N. and N.W. than from any other directions, and that these are especially the directions from which winds of high velocity come. This is strikingly shown by the fact that 75 per cent. of all the high winds which occurred during 1879 came from N. and N.W. The N. and N.W. winds prevail from November to March, and S. and S.E. winds from May to August, the other months being transitional; and with reference to these S. and S.E. summer winds it is clearly shown that they blow with a much less absolute velocity than do the N. and N.W. winds of the winter months.

Of almost equal importance are the facts of the rainfall. The amount for 1879 was 58·98 inches, the rainiest months being May, June, September, and October, and the driest, November, December, January, July, and August. The rainfall is sorted according to the direction of the wind with which it fell; and the highly interesting results are arrived at that the greater number of rainstorms come from N. and N.W., that the heaviest rains come with N.W. winds, and that in no season are the S. and S.E. winds, not even in summer when they are the predominating winds, accompanied with the maximum rainfall as compared with other wind-directions. The rainfall partitioned in percentages according to the winds with which it fell were N. 18, N.E. 9, E. 9, S.E. 5, S. 7, S.W. 3, W. 17, and N.W. 32, there falling thus 67 per cent. of the whole rainfall with N., N.W., and W. winds.

Among the changes it is proposed by Prof. Mendenhall to be introduced are improved hygrometric observations, which were evidently not trustworthy for 1879; observations of earth-temperatures down perhaps to a depth of 40 feet; an extension of the anemometrical observations; observations of variations in the velocity of sound under different meteorological conditions, the data being obtained from the time-gun, which is fired at noon daily; and a systematic investigation of the phenomena of earthquakes.

But what is urgently required in developing the meteorology of Japan is, beyond all question, the establishment of a network of stations over the Islands equipped with trustworthy instruments. The sub-tropical situation of Japan between the largest continent and the largest ocean of the globe is, from a meteorologist's point of view, unique; and the report now under review points to meteorological peculiarities in its climate of the highest interest. A satisfactory statement of its climatic peculiarities is, as our readers are aware, a desideratum; and the information which could not fail to prove of the highest utility to the Japanese, and is certain to cast important lights on the meteorology of Asia and the Pacific, and particularly on the meteorology of this ocean about latitude 33°, south to which the islands extend, can be furnished from no other source than from a network of meteorological stations overspreading Japan.

MINERAL STATISTICS OF VICTORIA

FOR some years past the yield of gold in the colony has been steadily decreasing. In 1868 the quantity of the precious metal obtained from alluvial deposits amounted to 1,087,502 ounces, and from quartz-veins 597,416 ounces, making in all 1,684,918 ounces of gold. Last year the quantities were respectively—alluvial, 293,310; quartz, 465,637: making a total of 758,947 ounces. The comparatively rapid diminution in the supply from alluvial sources is quite intelligible, as these would necessarily be soonest exhausted, though it is important to observe that in 1879 for the first time for eleven years the return from this source shows a decided advance on that of the preceding year, which is attributed to a better supply of water for sluicing operations, and to the opening up of deep mining ground. It is to quartz-mining, however, that the colony must look for the further development of her gold-fields. There has been a gradual decline in the yield from quartz-mines since 1872, when the amount obtained was 691,826 ounces. But the Secretary for Mines in his recent report speaks hopefully of the probable future of this important industry. Up to the end of 1879 the total quantity of gold raised in Victoria is estimated to have been 48,719,930 oz. 11 dwts., valued at 194,879,722*l.* The proportion of gold in the quartz varies considerably in different districts. Thus, last year at Castlemaine the average yield of each ton of quartz was 5 dwts. 18·45 grs., while in Gippsland it amounted to 1 oz. 2 dwts. 18·66 grs. The quartz of the latter locality is by much the most auriferous in the colony. The decrease in the supply of gold has been accompanied by a falling off in the number of miners. The men who found employment in gold mining in 1874 was 45,151; last year they numbered 37,553, which was an increase, however, of 917 over the number for 1878. The mining population includes an industrious and unpopular contingent of Chinamen, who last year amounted to 9,110, or 528 fewer than in the previous year. Taking the total annual yield of gold and dividing its value among the miners employed, the earnings of an alluvial miner are rated last year at 48*l.* 10*s.* 1½*d.* per annum., while those of the quartz miners are given as 118*l.* 8*s.* 7*d.* Deep mining in quartz reefs continues to make progress, and the mines are becoming every year deeper. Some shafts are now more than 2,000 feet deep. The revenue derived by the colony from the gold districts amounted last year to 15,641*l.* 16*s.* 9*d.*, being a slight advance on that of 1878.

PHYSICS WITHOUT APPARATUS[1]

II.

AMONGST the elementary principles of mechanics which are capable of easy illustration without special apparatus is that of the centre of gravity. In every solid mass a point can be found such that the resultant of all parallel forces acting on the individual particles passes through it, and such forces balance themselves around this point. The gravitation-force of the earth is exerted towards its centre, but this being 4,000 miles away, the individual forces acting on the separate particles of a body on the earth's surface may be regarded as parallel forces. Hence the centre of the parallel gravitation-forces is termed the centre of gravity. If the centre of gravity be supported, that is to say, if the resultant force be met by an equal and opposite force of resistance, then the body will not fall. The leaning tower of Pisa does not fall because, in the first place, the mortar is strong enough to bind the masonry into a substantial whole, and, in the second place, because the obliquity of the inclination of the tower is not so great as to throw the centre of gravity beyond the supporting base. A vertical plumb-line dropped down from the centre of gravity of the tower would meet the ground inside the base. It is very easy to imitate the leaning tower by taking a common wooden roller and sawing off a piece with oblique ends. The toys which are sold under the name of the Toy Blondin also illustrate the principle of the centre of gravity. A metal figure slides or walks down a stretched string, being kept upright by means of a weight fixed to the end of the rod held in the hand of the figure, thus causing the centre of gravity of the whole to fall below the point of support. A simple way of showing the same thing with improvised material is illustrated in Fig. 3. A couple of forks are stuck into a cork.

[1] Continued from p. 322.

Their weight being considerable, the centre of gravity of the combination is below the cork, and if the cork be placed on the tip of the figure or on the lip of a wine-bottle, it will stand there securely even while the bottle is emptied. M. Tissandier has revived another illustration of the same principle which is capable of evoking roars of laughter at a dinner-table. If a dish of snipe has been served up the head with its long beak may be fixed in a cork; and then, two forks being thrust into the sides of the cork and a needle having been fixed into the lower end of it, the cork can be balanced upon a coin laid on the top of a wine-bottle, and can be spun slowly round while the snipe's head nods at the various members of the company in turn, and finally stops opposite one of them (Fig. 4).

FIG. 3.

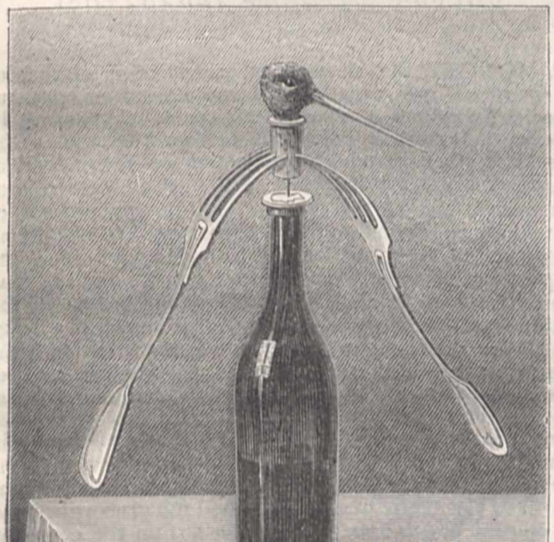


FIG. 4.

A pretty mechanical toy formerly sold in many shops, but now rather rarely met with, is explained upon the principle laid down above. Two small wooden figures with large feet, and holding a couple of poles palanquin-wise between them, are set at the top of a flight of toy stairs. They descend performing summersaults over one another. Fig. 5 shows how the two figures are set at starting. The poles which they grasp are in reality glass tubes plugged at the ends and containing a small quantity of mercury. The figures are themselves made of very light wood, and the quantity of mercury is adjusted to a nicety, so that its position in the tubes determines the position of the centre of gravity of the combination. Fig. 6 shows the position of the mercury in the end *a* of the tube. At this stage of the movement the figure marked R is still standing on the topmost step. The other figure, S, is descending, as shown by the arrow. The position of the figure S, with the feet foremost, is determined by light silk threads which connect the shoulders of R with those of S, and in this position S has the advantage in weight over the counterbalancing mercury at *a*, hence S continues to descend until the tubes have passed the position in which they are level. Once past this position the mercury runs down from *a* to *b* and brings down S firmly on to his feet on the second step. At this juncture the arrangement of the various parts will be that indicated in Fig. 7. The hands of S now become the pivot about which the poles can turn and the mercury in *b* is collected right in the bottom of the tube, where it has the greatest leverage. The feet of R (which are

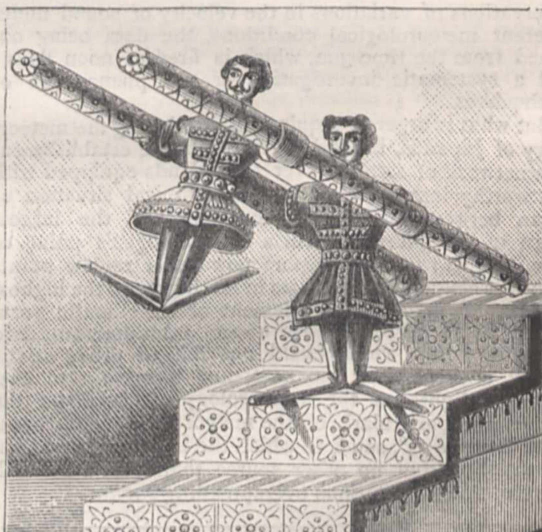


FIG. 5.

proportionally the heaviest part of him) are near to S, and his centre of gravity is therefore comparatively near to the pivot about which the combination is going to revolve. Hence while *b* sinks, R rises, and as he performs his

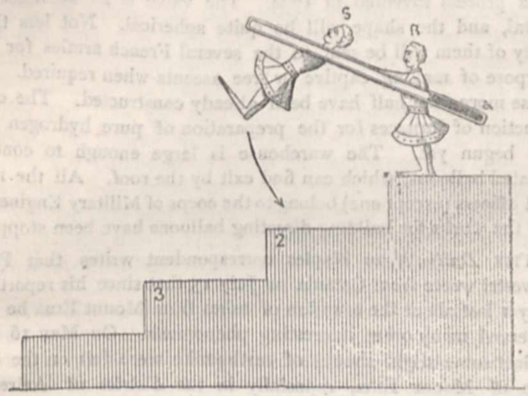


FIG. 6.

flight through the air over the head of S the silken strings gradually bring his feet forward until at last he has turned them forward so much that he has the greater leverage over the counterbalancing mercury at *b* and

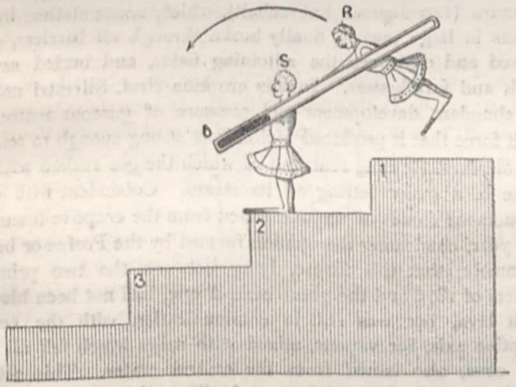


FIG. 7.

descends ready to take his stand on the third step. In this way the two manikins vault over one another's heads until they have descended from top to bottom of their tiny flight of stairs.

(*To be continued.*)

NOTES

THE French deep-sea exploring expedition off the North Coast of Spain in the Bay of Biscay, last month, appears to have been very successful, and to have fully confirmed the great reputation formerly earned by our neighbours in similar undertakings throughout the wide ocean. No less than 103 soundings were taken. The fauna agrees with that which was observed in the *Porcupine* cruise of 1870 along the western coasts of Spain and Portugal; and there are corresponding inequalities in depth. We understand that, with the approval of the French Commission, Dr. Gwyn Jeffreys will give an account of this expedition at the Swansea meeting of the British Association. The Paris report in the *Times* of August 5 is not quite correct.

THE American Association for the Advancement of Science meets this year at Boston, on the same day as our own does at Swansea, August 25. From the Local Committee's circular, which has been sent us, it is evident that a "good time" is in store for those who attend the meeting, and they are likely to be many. It seems to us that the organisation of the American Association is much better than ours, though it will be seen from last week's NATURE that the Swansea Committee have taken great pains to give the British Association an agreeable reception. The Boston Local Committee contains many well-known names, and is subdivided into a Committee-at-Large, Reception Committee (which includes the names of numerous ladies, headed by Mrs. Louis Agassiz), Committees on Finance, Railroads, Hotels and Lodgings, Rooms for Meetings, Mails, Express, and Telegraph, and Excursions. On these committees we find such names as Ralph Waldo Emerson, Asa Gray, Oliver Wendell Holmes, Henry W. Longfellow, A. Graham Bell, A. Agassiz, and many others eminent both in science and literature. The arrangements for excursions and receptions seem admirable, and the *savants* will have a terrible round of pleasure to undergo. Among other provisions by the Local Committee is a daily free public luncheon between the morning and afternoon sectional meetings, for the purpose of keeping the members together. The circular contains all information about hotels and lodgings, receptions, excursions, meetings, &c., and ample provision has been made in the various rooms for experiments and illustrations. The rooms will be connected by telephone with each other, with the hotels, and with the general telephone circuit of Boston and Cambridge. Indicators in each of the sectional rooms, as well as in the secretary's room and in the hotel selected for head-quarters, will show at any moment what papers are under discussion in each of the sections. Among the public addresses to be given during the meeting are those of the retiring president, Prof. G. F. Barker, the vice-president of Section A, Prof. Asaph Hall, and the vice-president of Section B, Mr. Alexander Agassiz.

THE Annual Meeting of the British Medical Association was opened at Cambridge on Tuesday, under the presidency of Prof. Humphry.

THE Institution of Mechanical Engineers had a very successful meeting last week at Barrow-in-Furness. Every facility was afforded the members for inspecting the many objects of engineering interest in Barrow and its vicinity. The papers read were all of more or less technical interest.

ON Thursday last the Anthropological Congress was opened at Berlin in the presence of the Crown Prince and Princess of Germany and of many distinguished literary and scientific men. Prof. Virchow delivered an eloquent speech. Dr. Schliemann afterwards gave an account of his discoveries and excavations. On Monday a banquet was given in honour of Dr. Schliemann and Prof. Nordenskjöld, who, on Tuesday, were entertained by the Crown Prince.

IN connection with the vote for the British Museum on Monday there was some talk as to the organisation of that institution and of the new Natural History Museum. Mr. Walpole spoke hopefully of the early transference of all the collections destined for the South Kensington buildings, while Mr. Story-Maskelyne, tenderly remembering his former colleagues, advocated the erection of houses for the officials. There was a good deal of vague and unsatisfactory talk about the distribution of duplicates to provincial museums. This is evidently a matter that requires clearing up, and it might be well to take means to decide once for all what are duplicates and what would be the best method of disposing of them. Mr. M'Cullagh Torrens thought there was great room for reform in the method of appointing the Trustees of the British Museum, who are far from being representative; there should, he thinks, be a larger infusion of the scientific element among them.

A CORRESPONDENT sends us some notes as the result of a visit to the Belgian National Exhibition at Brussels. The total extent of the ground is 300,000 square metres, and the area covered by the palace 70,000. The number of exhibitors is 7,000, or more than one for each 1,000 inhabitants in a population of about 6,000,000. Two of the pavilions are occupied by the two principal telephonic companies, who are competing at Brussels, Antwerp, and Verviers, where rival central offices have been built, and are besieged by a crowd of experimenters. The number of tickets sold at the gate is about 10,000 a day, which is considered a success. It was attempted to establish a captive balloon on the model of the large Giffard captive balloon on a reduced scale, the rope being only 300 metres long instead of 500, and the volume 8,400 cubic metres instead of 25,000. But in spite of this diminution the balloon refused to go up, the hydrogen having been mixed with a large quantity of common air. The Belgian balloon has been disinflated, and fresh efforts will be made to fill it with better gas, but success is considered rather doubtful. Except this disappointment, which it shares with Berlin, Vienna, and New York, where attempts to start a captive balloon failed, everything is going on remarkably well at Brussels. It is difficult to give a brief description of all the objects worthy of notice in this wonderful display of Belgian enterprise and skill. In the engine hall a facsimile of the first locomotive constructed on the continent has been placed. It bears the date of 1835, and an inscription shows it was made by Cockerill for the Belgian Government Railway. One of the wonders of the Exhibition is the collection of models of mining, showing all the incidents of underground workings and living. Scientific societies and Government exhibit complete collections of the mineral and vegetable kingdoms within the limits of Belgian territory. Every provincial Government is an exhibitor, and also the various Central Government Departments. The Belgian Photographic Society has organised a very good display. The Brussels Observatory has sent a model of van Rysselberghe's self-registering meteorograph. This apparatus is in operation at the Brussels Observatory, in Antwerp, at Ostend, and at Arlon. When the Belgian Observatory is moved to a new situation at some distance from the city, all these instruments will be connected with it by a special telegraph wire, so that the physicists of the Meterological Office will write their predictions in a room where they will be able to watch the development of meteorological phenomena all over their native country. An electrical railway has been established in the gardens, and is working all day long with perfect regularity. The number of waggons is three, each of them carrying six passengers, with a velocity of 3 metres per second, to a distance of 300 metres, for 3*d*. The locomotive, of which the weight is 800 kilogs., carries a Gramme machine, worked by another machine, which is stationary. There is also in another part of the city a so-called International Exhibition, but this, although opened in state by the King, is merely a private speculation, without having any special feature or deserving any particular notice.

SIR WILLIAM HARCOURT stated in the House of Commons the other day that it is hoped that the work of the Cambridge University Commissioners will be completed before the Christmas Vacation.

PROF. MENDELEEF is at present in the Caucasus. He intends to visit Vladikavkaz, Tiflis, Batoum, and Poti, whence he proposes to proceed to Kertch to inspect the sources of petroleum.

THE ladies continue to keep well to the front in the University of London Examinations. In the first division of the first B.Sc. examination the fourth on the list is Miss Sophia Bryant. The other five ladies are well up in this division, there being none so low as the second. In the first division of the first B.A. Examination the second on the list is Miss Catherine Eyre Anelay.

GREAT activity prevails at the Meudon aëronautical school, where the French Government has established extensive works for the construction of a large number of war balloons. Each of these, 10 metres in diameter, will be made of silk, varnished by a process invented in 1794. The valve is to be made of metal, and the shape will be quite spherical. Not less than forty of them will be sent to the several French armies for the purpose of making captive or free ascents when required. Of these more than half have been already constructed. The construction of furnaces for the preparation of pure hydrogen has not begun yet. The warehouse is large enough to contain inflated balloons, which can find exit by the roof. All the men and officers (except one) belong to the corps of Military Engineers. All the works for building directing balloons have been stopped.

THE *Daily News* Naples correspondent writes that Prof. Silvestri wrote from Catania on July 15 that since his report on May 1 last about the eruption of ashes from Mount Etna he has observed many other interesting phenomena. On May 16 and 17 last some slight shocks of earthquake were felt on the east side of Mount Etna, especially in the district of Acireale. About a month later the shocks commenced again and were repeated on several consecutive days—that is on June 15, 16, 17, and 18. The motion was undulating. About two days before these manifestations a new and very active phase of mud eruptions set in at Paterno, on the south-east of Etna. Two craters opened, which violently ejected gaseous matter with abundant torrents of mud, more consistent than usual, and of a higher temperature (140 degrees Fahrenheit), which, accumulating in the basins in large masses, finally broke through all barriers, overflowed and destroyed the adjoining fields, and buried several mills and farmhouses. In this eruption Prof. Silvestri noticed an abundant development and pressure of gaseous matter, of such force that it produced oscillations strong enough to tear up the old lava, forming rents out of which the gas rushed with the noise of a boiler letting off its steam. Coincident with these phenomena clouds of vapour issued from the eruptive fissure of last year, confirming the opinion formed by the Professor before—namely, that this fissure, lying between the two principal craters of 1879 and the great central one, had not been blocked with lava, but was still in communication with the central eruptive axis, for vapour, mixed with ashes which fell all over the cone, also issued from the central crater. This activity continued during several days, and still continues with decreased intensity, seen from Catania in the shape of dense clouds covering the whole summit of Etna in a clear sky. Changes have taken place which have entirely altered the form of the central crater. The old ravine, which formerly crossed the crater and made two-thirds of it into an ample and easily accessible basin, a natural laboratory for the study of the products of the volcano, now exists no longer. The central crater, from the effects of violent commotions, has crumbled, and, with part of its sides and the high point whence it was formerly possible to enjoy the sunrise, has been precipitated into the ravine, diminishing the height of the mountain by about 40 feet, while the circumference of the crater has become wider by half a kilometre. The general destruction of the old sides has in a certain way rejuvenised the crater, which has regained its characteristic form of a funnel, at the bottom of which is now the eruptive mouth.

A LETTER from San José de Guatemala, dated July 2, to the *Panama Star and Herald*, says:—"At 3 a.m. on June 29 the volcano Fuego suddenly became active, throwing out vast showers of fire and cinders, with great darts of flame shooting up from 350 feet to 500 feet above the mouth of the crater. The whole country to the east and south was magnificently illuminated. At 3.40 a.m. two streams of lava could be seen running down the sides of the volcano, one to the south and east, the other to the westward. Dense masses of steam and smoke rose from the courses of the lava streams, as the shrubbery and foliage were burnt. The river Guacalate rose suddenly, and its waters were quite warm. Fuego continued to belch fire until daylight, by which time the whole northern horizon, looking from San José, was dark with the smoke from the volcano. The lava streams continued in view until 4.30 a.m. The first grand column of fire rose at least 500 feet in height, solid and smooth, and then the top, expanding, opened out like an umbrella, the sparks coruscating like those from a brilliant rocket. The pulsations of flame during the first two hours of the eruption were about 50 seconds apart, strong and regular. The eruption was less active until, at 7.30 p.m. on July 1, a column of flame rose to a height, probably, of 150 feet or more. At the hour of writing Fuego smokes away steadily."

A REMARKABLE thunderstorm is reported as having occurred on July 24 last at Moylough, county Galway, Ireland. The storm, which was very vivid and accompanied by a most destructive fall of enormous hailstones, lasted about an hour and a half. One of the strongest discharges took place in a field about a mile from Moylough Church. The spot is described as presenting on a large scale an appearance like that of a sheet of cardboard that has been pierced by the discharge of a battery of Leyden jars. A long branching furrow, upturned as if by a plough, was found, a deep hole being bored at each end of six terminal branches, the earth round the holes being raised as if pushed up from below. Tufts of grass were scattered thirty and forty yards from the place.

MR. W. BRANKSTON RICHARDSON, writing from 61, Sutherland Gardens, Maida Vale, sends the following dog-story to the *Times*:—"Concurrently with the forty days' fast of the misguided American doctor, another fast has been in progress in our own country, for the truth of which I myself can vouch. A friend of mine who lives in Devonshire left home some weeks since on a series of visits to his friends in distant parts of the country. A few days after he left his servants wrote him that a favourite Skye terrier was missing. My friend, after every search had proved fruitless, considered that the dog had been stolen. On his return home, after an absence of one month and five days, he unlocked the library, the doors and windows of which had been bolted and barred during his absence, and to his astonishment the missing dog crept out into the light, a living skeleton and totally blind. He was well cared for, and has now quite recovered his health and sight. But his existence was wonderful. He had had no food and no water, and had not gnawed the books or obtained sustenance from any source whatever."

IT is at present too early to offer an opinion as to whether "Brook's Popular Botany: comprising all the Plants, British and Foreign, most useful to Man in Medicine, Food, Manufactures, and the Garden," is likely to answer to its title, since so much depends on its completeness. In the two numbers which we have at present received the letterpress seems fairly accurate, if not scientifically precise; but the illustrations are on too small a scale, and altogether wanting in detail. The publication is at all events cheap enough.

THE City of Nancy has instituted at its own expense a competition among aëronauts. A premium of 80*l*. has been offered to the aëronaut who on an ascent made from Nancy shall have made the best observations. MM. Eugène Godard and Duruof have entered the lists.

IN the beginning of September a statue erected to Pascal by ublic subscription will be inaugurated at Clermont. The principal address will be delivered by M. Bardoux, ex-Minister of Public Instruction, and member for Clermont.

EVERY year the laureates of the Municipal Schools of Paris travel during their holidays at the expense of the Municipality. The pupils of the Turgot School will visit Chambéry, those of the Lavoisier School, Havre, and those of the Colbert School, Chambéry. The pupils of the J. B. Say School will go to Clermont-Ferrand and witness the inauguration of Pascal's statue.

M. MAURICE KOECHLIN of Mulhouse, although born deaf and dumb, has passed successfully his examinations for baccalaureat at Rouen. He was educated by M. Hugentobler, director of an institution for such unfortunate persons. This young man is only sixteen years old, and his wonderful success has created quite a sensation.

THE Sixth Annual Report of the Yorkshire College for 1879-80 speaks with satisfaction of the progress of that institution. Instruction is now given in fourteen distinct subjects by twelve professors, lecturers, and instructors, aided by nine assistants. The number of students had increased to 142 from 113 of the previous year; there were besides 52 medical and 148 occasional students.

THE additions to the Zoological Society's Gardens during the past week include two Lesser Black-backed Gulls (*Larus fuscus*), British, presented by Mr. Beazley; a Horned Lizard (*Phrynosoma cornutum*) from Texas, presented by Mr. Luiz de Tavaris Ozorio, a Red-handed Tamarin (*Midas rufimanus*) from Surinam, two Russ' Weaver Birds (*Quelea russi*) from West Africa, deposited; a Servaline Cat (*Felis servalina*), a Coquetoon Antelope (*Cephalophus rufilatus*) from West Africa, a White-cheeked Capuchin (*Cebus lunatus*) from Brazil, four Brown Capuchins (*Cebus fatuellus*) from Guiana, two Swainson's Lorikeets (*Trichoglossus novæ-hollandiæ*) from Australia, an Anaconda (*Eunectes murinus*) from Demarara, purchased; a Mesopotamian Fallow Deer (*Cervus mesopotamicus*), a Gaimard's Rat Kangaroo (*Hypsiprymnus gaimardi*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

COMETS OF SHORT PERIOD.—Faye's comet was detected by Mr. Common at Ealing, with his large reflector, on August 2, in the position given by Dr. Axel Möller's ephemeris. The theoretical intensity of light at this date was 0·078, which rather exceeds that at the first and last observations at the appearance in 1850–51. The comet was very small and extremely faint when the sky was not quite black. The perihelion passage does not take place until January 22, 1881, but although long visible, the faintness of the comet will prevent its being well observed at any time with ordinary telescopes. Since its last appearance in 1873, when only four observations were secured, the effect of perturbation has been to lengthen the period 56·5 days, and to retard the arrival at perihelion by 38 days, the main part of this perturbation having been produced by Jupiter in 1875.

Prof. Oppölzer has published an ephemeris of Winnecke's comet from elements brought up to the next perihelion passage (December 4). The track of the comet will be so unfavourable that it is very doubtful if observations can be obtained at this return. If the comet be glimpsed at all, it is most likely to be during the month following December 20, for which period, that nothing may be wanting on his part, Prof. Oppölzer has given an accurately-calculated ephemeris, which he thinks will indicate the position within two minutes of arc. The three returns in 1858, 1869, and 1875 were connected, taking into account the perturbations by Jupiter and Saturn, and Herr A. Palisa determined the effect of the same planets (first-power perturbations) from 1875 to December 1, 1880. The effect of a resisting medium was likewise included, Prof. Oppölzer having, as we lately recorded, found evidence of its sensible influence on the motion of this comet, unless a correction be applied to the received mass of Jupiter, which seems hardly admissible to the extent required.

Encke's comet will again arrive at perihelion about the first week in November, 1881, after which no one of the comets of short period will be due until January, 1884, but before that time it may be anticipated that the comet of 1812 will have arrived in these parts of space. A search for this body with the aid of Prof. Winnecke's sweeping ephemerides is desirable forthwith, the length of the revolution not appearing to be determinable within very narrow limits from the observations of 1812, and there being no other recognised appearance.

IS η CYGNI A VARIABLE STAR?—Writing in September, 1842, Sir John Herschel drew attention to this star, which he said appeared to have increased very considerably in magnitude since the date of Piazzi's observations. In 1842 it was "the principal star in the neck of the Swan, and of nearly the fourth magnitude, very conspicuous to the naked eye, and making in fact the only very distinctly seizable point between *Albireo* in the beak and the bright star γ in the body."

Piazzi, who observed the star nineteen times in right ascension and eleven times in declination, calls it 6·7 m. D'Agelet had estimated it 4·5 on July 29, 1783, and 5 on September 17, 1784; Lalande, 5 on August 12, 1793, and 4 on July 14, 1797; Bessel in his zone 436 on September 8, 1828, calls it 3 m. (!); Argelander and Heis, 4·5. Thus Piazzi's estimate appears to be lower than in the case of any other modern observer, but it is to be noted that Flamsteed reckoned the star no higher than the *sixth* magnitude.

η Cygni seems to deserve some attention at the hands of observers of the variable stars.

GEOLOGICAL NOTES

GEOLOGY OF BELGIUM AND THE NORTH OF FRANCE.—M. Mourlon of Brussels has just published a work devoted to the general geology of Belgium. It describes the formations in chronological series, and is illustrated with maps, sections, and plates of the microscopic structure of rocks. A useful feature in it is a full bibliography of Belgian geology brought up to date. The new Government Geological Survey of Belgium has just published three sheets of maps, with sections, and explanatory notices. The maps, on a scale of $\frac{1}{20000}$, are printed in chromolithography and on a novel plan. The ordinary topographical features—roads, fences, trees, houses, &c., are printed in different colours, according to the tertiary formation lying underneath. Thus the Wemmelien (Eocene) areas are at once recognisable by an orange topography, the Oligocene tracts by one in slate colour and the Anversian (Miocene) by one in crimson. The quaternary deposits overlying these formations are expressed by broad tints of colour. The maps are accompanied by "Notices Explicatives," which in the case of the Hoboken and Contich sheets appear as a well-printed 8vo pamphlet of 256 pages, and a sheet of superficial sections on a scale of $\frac{1}{40000}$ for length and $\frac{1}{1000}$ for height. The country delineated and described lies on the low ground drained by the Escaut and Rupel, where, as little can be seen at the surface, a large series of borings has been made. The work has been accomplished by the Baron O. van Ertborn, with the co-operation of M. Cogels. Prof. Gosselet of Lille has just issued the first fasciculus of an essay on the geology of the North of France and the neighbouring regions. It deals with the palæozoic formations, and is accompanied with an atlas of plates of fossils, maps, and sections. No one is so competent as M. Gosselet to describe the older formations of that district which he has so sedulously studied for many years. His volume will be welcomed not only by students in Belgium and the North of France, but by geologists in other countries, who will find in it an admirable *résumé* of all that is known on this subject up to the present time, and references to the more important original memoirs where fuller information can be had.

THE RIGHT OF PRIORITY IN PALÆONTOLOGICAL NOMENCLATURE.—M. Gosselet, in a communication to the Société Géologique du Nord, calls attention to the great inconveniences which arise from the multiplication of names for the same species. He suggests the establishment of an international tribunal for judging of the value of each new species, and for registering it, with its name and the exact date of its publication. He thinks that the expenses of the journal of such a commission would be easily met by the subscriptions of scientific men, and that the duties of the commissioners would not be heavy, as they would need to be consulted only occasionally in doubtful cases, the ordinary routine work being performed by a secretary. As illustrations of the evils of the present system, or, rather, want of system, he cites the history of some Spirifers.

GEOLOGICAL SURVEY OF NEW JERSEY.—Mr. George H. Cook, State Geologist of New Jersey, has issued his unpretending but useful Annual Report for 1879. It contains a record of the development of the mineral industries of the State for last year, and is accompanied with a good map, on which are delineated the various soils as distributed over the area. The iron-bearing rocks of the Archæan series extend from the north across New Jersey, and for several generations iron has been worked in this State. It is chiefly magnetic ore, and is searched for by means of the compass-needle, the attraction of which is noted. The commercial depression which began in 1873 has told heavily on the iron manufacture in the State. Of 200 mines and localities for ore only thirty have been kept in operation during the whole period of depression. There are now hopeful indications however of a revival of the trade. In the midst of information about building-materials, soils, mines, water-supply, and other topics, the writer of the Report continues to find a place for occasional interesting geological facts. His chapters are likely to be of much service to his fellow-citizens, who, it is pleasant to learn, show their appreciation of these Annual Reports, of which many of the former volumes are out of print.

GEOLOGICAL SURVEY OF ALABAMA.—The Geological Survey of this State is very modestly equipped. Its director, Prof. Eugene A. Smith, issues Annual Reports, which show, as minutely as the resources at his command will allow, the geological structure and economic resources of the different counties of the State. But he cannot make bricks without straw. It is short-sighted policy to require a Geological Survey to be made, and to equip it so economically that it cannot efficiently perform its work. In a country where the mineral resources remain in great measure undeveloped, it would be a wise expenditure of public funds to furnish means for making cuttings or borings where the crop of a seam of coal or vein of ore might be revealed at a short distance below the surface.

CENTRAL ASIAN GEOLOGY.—We find in the last number of the *Izvestia* of the Russian Geographical Society information as to the geological structure of the tracts to be crossed by the Southern Central Asian Railway. Altogether it is a flat and dry desert, covered with recent alluvial formations; the land becomes hilly only in the Mugojar Mountains. At Orenburg, and as far as Mertvyia Soli, there appear Trias sandstones and clays, which cover the Permian limestones, and gypsum with salt-springs (Sletskaya Zaschita). In the neighbourhood of Khanskiy Post we find a formation which probably will have an importance for the railway, namely, the Jura, which contains coal. At Ak-tube the shores of Teres-bvutak, Yakshi, and Djaman-kargal Rivers are craggy, and consist of Permian and Trias rocks. The Mugojar Mountains are formed of pretty green and red jades, and the Djaman-tau Mountains of an augitic porphyry of syenite and granite; gneiss and mica-slate cover the granite on the eastern slope. A kind of fine white clay, being a product of the trituration of rocks, is found at the foot of the Mugojar Mountains on both slopes, and large accumulations of gravel in the form of mounds appear at a short distance from the mountains to the east. The Karakorum steppe affords a series of mounds of sand mostly covered with vegetation and often with very old trees. These mounds are usually motionless, only those which are quite devoid of vegetation (such being exceptional) are set in motion during heavy storms. Altogether the structure of the steppe appears thus: At the base a sandstone, probably Tertiary, horizontally stratified; above this, a clay with gypsum borrowed by former watercourses, and above it the sandy mounds. Water is found at a small depth. Sandstone and clays forming low elongated terraces, and belonging possibly to the Jurassic formation, appear in the neighbourhood of Kara-tougay on the Syr-daria River.

GEOLOGY OF GENEVA.—The Geological Map of the Canton of Geneva, on the scale of 1 to 25,000, together with a "Geological Description of the Canton," in two volumes, by Prof. Alphonse Favre, have been published under the auspices of the Geneva Agricultural Society—the map a year ago, and the "Description" only now. The map is well printed with eight colours very agreeable to the eye, and sufficiently transparent not to obstruct the topographical details. As to the geological value of this work, the name of M. Favre is a sufficient warrant. The learned professor has spent no less than twenty-seven years in the study of the formations of his Canton. The "Description" consists of four parts. The first gives general notions in geology; the second contains a detailed description of the formations of the Canton, namely, the Molasse, the glacial and the post-glacial deposits with numerous analyses of soil which give to this part a great importance for agriculture. The third part deals with erratic blocks as to their composition and origin; the fourth part describes subsoils, and contains a description of Lake Leman.

JURASSIC ROCKS OF THE ALTAI MOUNTAINS.—According to the researches of M. Schmalhausen, noticed in the *Memoirs* (*Troudy*) of the St. Petersburg Society of Naturalists, vol. x., the fossils of the Kouznetzk Carboniferous basin in the Altai Mountains, which fossils were described until now as palæozoic by Göppert in Tchikhatcheff's "Travels," by Eichwald, and by Heinitz in Cotta's "Altai," are identical with the Jurassic (Bathonian) plants which Heer has recently described in the Jurassic Flora of Eastern Siberia and Amour. M. Schmalhausen describes them as *Phyllothera*, *Asplenium whitbiense tenuis*, *Pterophyllum inflexum*, *Podozanistes lanceolatus*, Lindl., *Brachyphyllum*, and *Czekanowskia rigida*, Heer.

MIOCENE FLORA.—In his work, "Die Miocene Flora von Sakhalin," just published by the St. Petersburg Academy of Sciences, Prof. Schmidt describes 74 species of plants he has discovered, of which 43 were formerly known in other countries, and 31 are new; 27 are identical with Arctic Tertiary plants, 25 with Swiss, 18 with those of Alaska, and 21 with those of North America. The eighteen Alaska species are the most common of the Sakhalin Miocene flora, which circumstance, as well as the intermediate characters of the Tertiary flora of Kamchatka, is a new argument in favour of Asia, having formed, with America, one continent at this geological period. It is important to observe that the Tertiary flora of Sakhalin has more likeness to that of Greenland, of Spitzbergen, and of Switzerland, than to that of Central Siberia; thus, out of the eighteen species of Tertiary plants discovered by M. Lopatin on the banks of the Choulym River (not far from Krasnoyarsk), none were found among the Miocene fossils of Sakhalin, whilst the Tertiary flora of the southern shores of Lake Baïkal is very like that of Sakhalin and of Alaska. To explain these differences Prof. Schmidt supposes that the fossil plants which are all described by Heer as Miocene ought to be considered as belonging to an older substage, all the more that the Sakhalin plant-beds are very intimately connected with the marine chalk which they concordantly cover.

CHEMICAL NOTES

THE influence of sewage on potable waters is again being discussed. Herr R. Emmerich—in *Bied. Centralblatt*—makes an original contribution to the subject. He has for a long time daily drunk from a half to one litre of water from one of the Munich brooks which receives sewage of every kind; he has satisfied himself that there were cases of typhoid in some of the houses which drained into the brook. No bad effects having followed the consumption of this beverage, Herr Emmerich invites other experimenters to pursue investigations similar to his own! The same observer, however, finds that sewage water produces death in rabbits when injected subcutaneously in quantities of from 6 to 60 c.c., rabbits of a similar size being killed by the injection of 200 c.c. of distilled water. The injection of the residue from the evaporation of 500 c.c. of sewage water produced strong convulsions and death in rabbits. He proposes that suspected water may be examined by injecting 40 to 80 c.c. under the skin of a full-grown rabbit; if no rise of temperature greater than 1° occurs, or if death does not quickly follow the injection, the water would probably be uninjurious to human beings drinking it.

CITRIC acid has been formed synthetically by Grimaux and Adam. The process, which is described in the *Comptes rendus*, consists in forming dichloracetonic acid $CH_2Cl—COH\langle^{CO_2H}_{CH_2Cl}$ from symmetrical dichloracetone, itself produced from glycerin through the intermediate stage of dichlorhydrin. By saponifying, by means of hydrochloric acid, the sodium salt of dichloracetonic acid, citric acid is produced; this synthesis confirms the generally accepted structural formula of citric acid.

DOUBT as to the elementary nature of sulphur is expressed by Th. Gross because of recent experiments wherein he claims to have produced a black, nonoxidisable, chemically indifferent substance by heating perfectly pure sulphur with linseed oil, dissolving the product in sulphuric acid, and precipitating by sulphuretted hydrogen.

THE influence of very small quantities of foreign substances in modifying processes of chemical change is a subject of much interest to the chemist, although as yet no full explanation has been given of this class of phenomena. In the course of his researches at high temperatures Victor Meyer has given one or two instances of such reactions. Thus he finds that ferric chloride, aluminium chloride, and zinc chloride are decomposed with evolution of chlorine at much lower temperatures when the vapour-density apparatus is previously filled with nitrogen gas than when no foreign gas is present. Meyer cannot trace any connection between the temperature, or amount of decomposition, and the chemical nature of the foreign gas.

THE long-protracted discussion between Berthelot and Wurtz regarding the dissociation of the vapour of chloral hydrate appears at length to be closed; Berthelot admits in the *Comptes rendus* that the vapour is partly dissociated at 100°, and that if the pressure is small the dissociation is probably complete.

AN interesting experiment, and one likely to lead to further results, is described by Berthelot in the *Comptes rendus*. He finds that such unstable compounds as ozone, hydrogen peroxide, &c., are not affected by sonorous vibrations of the rapidity of 100 and 7,200 per second.

M. MEUNIER claims, in *Comptes rendus*, to have produced spinel crystals, and thinks he has also produced periclase and corundum by the action of steam on aluminium chloride, at a red heat, in presence of magnesium.

AMONG other results accruing from V. Meyer's recent determinations of vapour densities is the addition of six or eight substances to the small list of gaseous metallic compounds. From the densities, and analyses, of these compounds the following numbers may be deduced as representing the *smallest possible valency* of the element placed opposite each number:—Arsenic, 2; cadmium, 2; copper, 2; iron, 4; indium, 3; tin, 2; zinc, 2. The formula of stannous chloride is shown by Meyer to be Sn_2Cl_4 at about 700°, but $SnCl_2$ at 900°. Hence the valency of tin varies at different temperatures.

IN the last number of the *Berliner Berichte* an attempt is made by Wiebe to trace a connection between the atomic weights of elements and the molecular weights of carbon compounds, and the coefficients of expansion of the same substances. He shows that for many elements the ratio between the reciprocal of the number obtained by multiplying the atomic weight of an element into the mean coefficient of cubical expression from 0° to 100°, and the heat required to raise unit weight of the same element from absolute zero to the melting-point, is a nearly constant number. For elements crystalising in the regular system the mean value of the constant is 2·6; other elements show considerable divergences. For certain classes of carbon compounds the following equation is shown to hold: $\frac{A \cdot \alpha}{d} \cdot T = n.$ const., where A = molecular weight, α = mean cubical expansion from 0° to 100°, d = density of liquid compound, T = absolute boiling-point, and n = number of atoms in the gaseous molecule of the compound. The constant for the fatty acids and ethereal salts is from 3·1 to 3·8.

IN the *Proceedings* of the Asiatic Society of Japan R. W. Atkinson gives the results of his analyses of several Japanese porcelain clays; these results show that the opinion of H. Wurtz, viz., that Japanese porcelain is prepared from decomposed felspathic rocks alone, without admixture of kaolin, is not generally correct. Many of the clays analysed by Atkinson contained from 54 to 59 per cent. of silica, with 26 to 32 per cent. of alumina; others again contained from 73 to 79 per cent. of silica. In the clays exhibited in the Philadelphia Exhibition Wurtz found only one containing less than 74·5 per cent. of silica.

IN a series of papers by Nilson, and by Nilson and Pettersson, in the last number of the *Berliner Berichte*, important additions are made to our knowledge of the rarer earth metals. The existence of ytterbium seems proved. The atomic weight of this metal is 173 (mean of seven closely-agreeing determinations), assuming the formula of the oxide to be Yb_2O_3. The chief reasons for this formula are the isomorphism and general analogy of the sulphates of ytterbium, erbium, and didymium; the close analogy between the selenite of ytterbium and the selenites of metals which form oxides of the formula M_2O_3, and the molecular heat and molecular volume of Yb_2O_3 compared with the same constants for the group M_2O_3.

REASONS are given for adopting the formula of scandium oxide as Sc_2O_3, and the atomic weight of scandium is determined to be 44·0 (mean of four closely-agreeing results). Scandium is undoubtedly identical with Mendelejeff's ekabor.

THE specific heat of beryllium has been determined by Nilson and Pettersson. Between 0° and 100° the specific heat is 0·4246; between 0° and 300°, 0·5060. These chemists have likewise made a new determination of the combining weight of beryllium, and find it to be 4·55, which is a very little less than the number found by previous observers. They think that the atomic weight of beryllium is undoubtedly 13·65, and not 9·1, as generally supposed; oxide of beryllium is therefore Be_2O_3, and this metal is not to be placed, in Mendelejeff's system, as the first member of the magnesium group. Neither can beryllium form the first member of the aluminium group, as suggested by Lothar Meyer. Nilson and Pettersson detail many facts which lead them to regard beryllium as the first member of the group of cerite and gadolinite metals, which comprises the metals, Be, Sc, Y, La, Ce, Di, Tr, Y_α, Y_β, Soret's *x*, Er, Tu, Yb. The paper contains many most important chemical and physical data concerning the salts of the metals of this group.

FROM the specific heats of the oxides of beryllium, scandium, gallium, indium, and aluminium, the specific heat of oxygen in combination is deduced by Nilson and Pettersson as being 2·3 to 3·1; the mean specific heat of oxygen in combination is 4·0; the oxides named are therefore somewhat anomalous.

THE "molecular volume," *i.e.*, $\frac{\text{molecular weight of gas,}}{\text{sp. gr. of solid}}$ of the various molecules of water of hydration has been recently shown by Thorpe and Watts to vary in the magnesium group of sulphates; Nilson and Pettersson obtain nearly the same number (8·5) as representing the mean volume of each water-molecule in the sulphates of yttrium, erbium, and ytterbium; but a somewhat larger number (11·5) for the mean volume in the sulphates of cerium, lanthanum, and didymium.

PHYSICAL NOTES

IN liquids small particles often show dancing motions under the microscope, and similar motions have been attributed to dust-particles in air, and accounted for by the shock of molecules with the particles. In a recent paper treating fully of the movements of very minute bodies (*Münch. Ber.*, 1879, p. 389) Herr Nägeli calculates from data of the mechanical theory of gases as to the weight and number and collisions of molecules, the velocity of the smallest fungus-particles in the air that can be perceived with the best microscopes, supposing a nitrogen or oxygen molecule to drive against them. It is, at the most, as much as the velocity of the hour-hand of a watch, since these fungi are 300 million times heavier than a nitrogen or oxygen molecule. The ordinary motes would move 50 million times slower than the hour-hand of a watch. Numbers of the same magnitude are obtained for movements of small particles in liquids. In both cases a summation of the shocks of different molecules is not admissible, as the movements are equably distributed in all directions. Herr Nägeli therefore disputes the dancing motion of solar dust-particles, and attributes the Brownian molecular motion to forces active between the surface-molecules of the liquid and the small particles; but he does not say how he conceives of this action.

THE absorption of heat-rays by powders has been lately investigated by Herr van Deventer (*Inaug. Diss. Leid.*, 1879, p. 78, or *Wied. Beibl.*, 6) without use of any binding material. Under a copper cube kept at 100° was brought a thermo-element consisting of a brass plate, on the lower side of which was soldered a piece of bismuth and antimony (parallelopiped shape). On the plate was strewn the powder to be examined. A second similar element, with thermo-element lampblacked, served for control. Briefly, the results were these: (1) Powdered substances in the same physical state have different absorptive power; (2) this depends on the thickness of the absorbing layer: each powder has its maximum absorption layer; (3) quite comparable values for the absorption cannot be had, as the thickness of the powder layer cannot be exactly determined; (4) the divergences proved in Tyndall's results with different binding materials are attributed to his not having taken into account the maximum emission layer; (5) whether the binding material affects absorption, and if so, how, can be demonstrated by the author's method (the element being painted over with the liquid holding the powder in suspension): but experiments are here wanting; (6) the author's series of powders arranged according to absorption is quite different from Tyndall's emission series.

DR. PULUJ observes that if an electric radiometer is worked for some minutes and then the circuit is broken, a reversed motion is immediately set up, which continues for four or five minutes with an enormous rapidity. This he explains by assuming that there are really two actions tending to produce rotation: the electric reaction between the vanes and the molecules, and the heating of the metallic side of the vanes; that these two actions oppose one another, but that at small pressures, such as the high vacua, the electrical forces are in excess. When however they are brought to an end the heat-forces assert themselves, producing the opposite rotation.

FROM recent experiments (described in *Wied. Ann.*, No. 7) Herr Heitz concludes that the kinetic energy of the electric current in 1 cubic millimetre of a copper conductor, traversed by a current of unit electromagnetic density, is less than 0·008 milligramme-millimetre. As the kinetic energy is equal to half the mass multiplied by the square of the velocity, the mass of the positive electricity in 1 cub-mm. is $< \frac{0·008 \text{ mg.}}{v^2}$. *E.g.*, if $v = 1$ mm., 10 mm., &c., the mass of the positive electricity < 0·008 mg., < 0·00008 mg., &c. The limits here assigned, however, are exceeded where the densities of the electricity in the materials used are as their conductivities. (The experiments were made both with straight wires and with spirals, the former giving the more reliable results.)

THE results of theory regarding stationary vibrations of water are, in a recent paper (*Wied. Ann.*, No. 7) by Herr Kirchhoff and Herr Hansemann, compared with those of experiments in which a prismatic glass vessel, whose vertical cross-section consisted of two straight lines meeting at a right angle and equally inclined to the vertical, formed part of a pendulum, and was vibrated by electromagnetic means about that angle as axis. In the *Journal de Physique* (June) M. Lechat studies the surface vibrations of a liquid in a rectangular vessel, a small vertical rod having been adjusted to any point of the surface, and vibrated in the direction of its length by an electro-magnetic arrangement. The resultant forms were thrown on to a screen by means of a reflected beam of light.

IN a recent paper to the Belgian Academy (*Bull.*, No. 5) Abbé Spée contends that the spectral line D_3, with wave-length about 588, observed in the chromosphere and protuberances, and assigned to a hypothetical body, helium, which some suppose to have a still more simple molecular constitution than hydrogen, probably belongs in reality to this gas. As to its non-reversibility, he considers that at a very small distance from the chromosphere the solar hydrogen may be so far cooled as to be comparable to that which we manipulate, and so, unable to extinguish waves which it can no longer produce, just as a stretched cord loses the property of vibrating in sympathy if its tension have been altered.

PURSUING his researches on the welding of solid bodies by pressure, M. Spring has subjected to various strong pressures (up to 10,000 atm.) more than eighty solid pulverised bodies; this was done in vacuo, and in some cases at various temperatures. The results are highly interesting. All the crystalline bodies proved capable of welding, and in the case of bodies accidentally amorphous the compressed block showed crystalline fracture; crystallisation had been brought about by pressure. Softness favours the approximation of the particles and their orientation in the direction of the crystalline axes. The amorphous bodies, properly so called, fall into two groups, one of substances like wax (*ciroid* bodies), which weld easily, the other of substances like amorphous carbon (*aciroid* bodies), which do not weld. The general result is that the crystalline state favours the union of solid bodies, but the amorphous state does not always hinder it. M. Spring says the facts described do not essentially differ from those observed when two drops of a liquid meet and unite. Hardness is a relative, and one may even say subjective, term. Water may appear with a certain hardness to some insects, and if our bodies had a certain weight we should find the pavement too soft to bear us. Again, prismatic sulphur is changed by compression to octahedric sulphur; amorphous phosphorus seems to be changed to metallic; other amorphous bodies change their state, and mixtures of bodies react chemically if the specific volume of the product of the reaction is smaller than the sum of specific volumes of the reacting bodies. In all cases the body is changed into a denser variety, whence may be inferred that the state taken by matter is in relation to the volume it is obliged to occupy under action of external forces. This (M. Spring points out) is merely the generalisation of a well-known fact. Some curious results are deduced from it. The researches described have important bearings on mineralogy and geology.

MR. R. CROWE of Liverpool communicates to the *British Journal of Photography* an account of some attempts to photograph a landscape by the aid of lightning-flashes. A gelatine plate, requiring by day an exposure of two seconds, was exposed from 10.15 p.m. to 10.45 p.m., during which time there were 120 brilliant flashes and about half as many minor ones. Most of these were in a horizontal direction, and five or six of then were imprinted on the negative. A perpendicular flash which struck a church-tower half a mile away was rendered with extraordinary sharpness and brilliancy. The surrounding objects, in spite of the long exposure, were but feebly impressed; whence Mr. Crowe argues that though the light of a flash of lightning is of a very actinic character, there still is not sufficient volume of light to illuminate a landscape or building to allow a successful photograph to be taken. Mr. Crowe further suggests that an attempt should be made to photograph, for scientific purposes of reference, the varied forms assumed by lightning at different times and in different countries.

GEOGRAPHICAL NOTES

NEWS has been received from Zanzibar that Capt. Carter and Mr. Cadenhead, of the Belgian Exploration Expedition, have been killed by the chief "Wrambo." This is probably the chief Mirambo, who formerly caused so much trouble to explorers between Zanzibar and Lake Tanganyika, but of whom Mr. Stanley gives so good a report in his last work. It was Capt. Carter who was so successful in the introduction of Indian elephants into Africa.

THE August number of the Geographical Society's *Proceedings* contains Mr. im Thurm's paper on his journey in British Guiana, already noticed in our columns, but the principal feature this month is of course the paper on Kuldja by Major F. C. H. Clarke, R.A., a well-known military writer on Eastern affairs. After a useful historical sketch, Major Clarke deals successively with the geography, orography, rivers, communications, towns, population, climate, vegetable products, and minerals of the region, and furnishes much interesting information, collected with evident care. This paper is followed by an account of M. Severtsoff's journey in Ferghana and the Pamir, from a translation by M. Alexis Lomonossoff, of the Russian Geographical Society. The geographical notes furnish information respecting the East African Expedition, the climate of Matabele-land, the recent observations of Dr. Matteucci in Kordofan, and Dr. Gerhard Rohlfs' account of the Jofra oasis. After notes on American Arctic expeditions and the position of the Crozet Islands, we have Mr. Whymper's account of his ascent of the famous Antisana mountain in South America, and lastly Mr. A. Forrest's own narrative of his journey through North-Western Australia. Two maps are given with the present number, one of British Guiana, which is very acceptable, and the other of the Kuldja district and the Russo-Chinese frontier in Turkistan.

WITH the August number of their *Herald* the Baptist Missionary Society publish a map of Equatorial Africa, which, though presumably not laying claim to scientific accuracy, is of interest as showing what an immense region can be reached by means of the River Congo and its affluents. The map is intended to illustrate the scheme which Mr. Arthington has sketched out for the application of his last munificent donation to the Society. The geographical part of this great task consists in the exploration of the Nkutu and Ikelemba Rivers, the two principal tributaries of the Congo from the south, after passing Stanley Pool, and the opening of a route towards Lake Albert, along the Mbura River, which enters the Congo above Stanley's Arawimi.

M. C. E. DE UJFALVY left Paris in July to undertake a new and important journey in Central Asia. He goes in the first instance to Orenburg, and thence to Tashkend, where he hopes to arrive at the end of next month. He contemplates staying the winter at Samarkand, and will commence his explorations next spring. His programme is an extensive one, and embraces a considerable part of the Southern Pamir region. In the course of his labours he will visit the Upper Zarafshan valley, Karategin, Wakhan, Shignan, Badakshan, and probably Afghanistan. The return journey will, if possible, be made through Persia and the Caucasus.

NEWS has arrived in Paris that a French mission has reached Segon Sokkova and has been well received by King Ahmadan. M. Soleillet, who is on his way to Senegal, is not a member of this expedition, and will proceed by another route to the same city.

THE *Weimar Gazette* states that Dr. Gerhard Rholfs is about to set out for Abyssinia, accompanied by Dr. Stecker, who will attempt a new exploration in Central Africa.

IT is stated that a fifth Belgian Expedition is about to start for Africa, intended to reinforce the expedition on the Congo under Mr. Stanley. It will be commanded by Lieut. Braconnier.

THE August number of *Petermann's Mittheilungen* contains an exhaustive article by Dr. Behm on the Island of Rodriguez, accompanied by a very clear map. Bernhard v. Struve discusses the question of an inland trade-route through Siberia. An excellent hydrographical article, with a large-scale chart, on the Lower Weser from Bremen to Bremerhaven, is contributed by Oherbau-Director L. Franzius of Bremen. The results of the various East African International Expeditions are described. The researches of the Danish schooner *Ingolf* in the seas around Iceland in 1879 are described by H. Wiehmann.

THE London Missionary Society have received intelligence of the safe arrival of their new Tanganyika Expedition at Zanzibar on May 29. The party is composed of the Revs. A. J. Wookey and D. Williams, with Dr. Palmer as medical assistant. When the last mail left, an efficient leader and some of the head-men had already been engaged, and they hoped to start for the interior early in July.

THE Church Missionary Society are sending out further reinforcements for their Nyanza mission. The Rev. P. O'Flaherty, an able Oriental scholar, who was an interpreter on Lord Raglan's staff in the Crimean war, left for Zanzibar early in July, and will probably accompany the Waganda chiefs on their journey back to Lake Victoria. Mr. W. E. Taylor, of Hertford College, Oxford, who has been trained as a medical missionary, and Mr. A. J. Biddlecombe have, we believe, just started for East Africa, and will in the first instance join Mr. Copplestone at Uyui.

L'Exploration for August 5 contains some interesting extracts from the letters of Col. Prejevalsky, describing the difficulties he had to encounter in attempting to reach Lhassa, in which he was foiled. The intrepid Colonel has evidently succeeded in making considerable natural history collections.

THE STRUCTURE AND ORIGIN OF CORAL REEFS AND ISLANDS[1]

DARWIN'S THEORY.—During the voyage of the *Beagle* and subsequently, Mr. Darwin made a profound study of coral reefs, and has given a theory of their mode of formation which has since been universally accepted by scientific men.

Darwin's theory may be said to rest on two facts—the one physiological, and the other physical—the former, that those species of corals whose skeletons chiefly make up reefs cannot live in depths greater than from 20 to 30 fathoms; the latter, that the surface of the earth is continually undergoing slow elevation or subsidence.

The corals commence by growing up from the shallow waters surrounding an island, and form a fringing reef which is closely attached to the shore. The island slowly sinks, but the corals continually grow upwards, and keep the upper surface of the reef at a level with the waves of the ocean. When this has gone on for some time a wide navigable water channel is formed between the reef and the shores of the island, and we have a barrier reef. These processes have but to be continued some stages further, when the island will disappear beneath the ocean, and be replaced by an atoll with its lagoon where the island once stood.

According to this simple and beautiful theory, the fringing

[1] Abstract of paper read at the Royal Society of Edinburgh by Mr. John Murray. (Published by permission of the Lords Commissioners of the Treasury.)

reef becomes a barrier reef, and the barrier reef an atoll by a continuous process of development.

Object of the Present Paper.—Prof. Semper,[1] during his examination of the coral reefs in the Pelew group, experienced great difficulties in applying Darwin's theory. Similar difficulties presented themselves to the author in those coral-reef regions visited during the cruise of the *Challenger*.

The object of the present paper is to show, *first*, that, while it must be granted as generally true that reef-forming species of coral do not live at a depth greater than 30 or 40 fathoms, yet that there are other agencies at work in the tropical oceanic regions by which submarine elevations can be built up from very great depths so as to form a foundation for coral reefs; *second*, that while it must be granted that the surface of the earth has undergone many oscillations in recent geological times, yet that all the chief features of coral reefs and islands can be accounted for without calling in the aid of great and general subsidences.

Nature of Oceanic Islands and Submarine Elevations.—It is now known that, with scarcely an exception,[2] all oceanic islands other than coral atolls are of volcanic origin. Darwin, Dana, and others have noticed the close resemblance between atolls and ordinary islands in their manner of grouping as well as in their shapes. In a previous paper the author pointed out the wide distribution of volcanic *débris* over the bed of the ocean in tropical regions, and the almost total absence of minerals, such as quartz, which are characteristic of continental land.[3] There is every reason for believing that atolls are primarily situated on volcanic mountains, and not on submerged continental land, as is so often supposed.

The soundings of the *Tuscarora* and *Challenger* have made known numerous submarine elevations: mountains rising from the general level of the ocean's bed, at a depth of 2,500 or 3,000 fathoms, up to within a few hundred fathoms of the surface. Although now capped and flanked by deposits of Globigerina and Pteropod ooze, these mountains were most probably originally formed by volcanic eruptions. The deposits in deep water on either side of them were almost wholly made up of volcanic materials.

Volcanic mountains situated in the ocean basins, which during their formation had risen above the surface of the water, would assume a more or less sharp and pointed outline owing to the denuding action of the atmosphere and of the waves, and very extensive banks of the denuded materials would be formed around them. Some, like Graham's Island, might be wholly swept away, and only a bank with a few fathoms of water over it be left on the spot. In this way numerous foundations may have been prepared for barrier reefs and even atolls.

Those volcanoes which during their formation had not risen above the surface of the sea (and they were probably the most numerous) would assume a rounded and dome-like contour,[4] owing to the denser medium in which the eruptions had taken place, and the deposits which had been subsequently formed on their summits.

In order to clearly understand how a submarine mountain, say half a mile beneath the sea, can be built up sufficiently near the surface to form a foundation on which reef-forming corals might live, it is necessary to consider attentively the

Pelagic Fauna and Flora of Tropical Regions.—During the cruise of the *Challenger* much attention was paid to the subject. Every day while at sea tow-nets were dragged through the surface waters; and while dredging they were sent down to various depths beneath the surface. Everywhere life was most abundant in the surface and sub-surface waters. Almost every haul gave many calcareous, siliceous, and other Algæ; great numbers of Foraminifera and Radiolaria, Infusoria, Oceanic Hydrozoa, Medusæ, Annelids; vast numbers of microscopic and other Crustacea, Tunicates, Pelagic Gasteropods, Pteropods, Heteropods, Cephalopods, Fishes, and fish-eggs; larvæ of Echinoderms, and of many of the above creatures, &c.

Most of these organisms live from the surface down to about 100 fathoms.[5] In calm weather they swarm near the surface, but when it is rough they are to be found several fathoms beneath the waves. They are borne along in the great oceanic currents which are created by the winds, and meeting with coral reefs, they supply the corals on the outer edge of the reefs with abundant food. The reason why the windward side of a reef grows more vigorously appears to be this abundant supply of food, and not the more abundant supply of oxygen, as is generally stated. The *Challenger* researches showed that oxygen was particularly abundant in all depths inhabited by reef-forming corals.

When these surface animals die, either by coming in contact with colder water or from other causes, their shells and skeletons fall to the bottom, and carry down with them some organic matter which gives a supply of food to deep-sea animals. The majority of deep-sea animals live by eating the mud at the bottom.

An attempt was made to estimate the quantity of carbonate of lime in the form of calcareous Algæ, Foraminifera, Pteropods, Heteropods, Pelagic Gastropods, in the surface-waters. A tow-net, having a mouth 12½ inches in diameter, was dragged for as nearly as possible half a mile through the water. The shells collected were boiled in caustic potash, washed, and then weighed. The mean of four experiments gave 2·545 grammes. If these animals were as abundant in all the depth down to 100 fathoms as they were in the track followed by the tow-net, this would give over 16 tons of carbonate of lime in this form in a mass of the ocean one mile square by 100 fathoms.[1]

Bathymetrical Distribution of the Calcareous Shells and Skeletons of Surface Organisms.—Although these lime-secreting organisms are so abundant in tropical surface waters, their cast-off shells and skeletons are either wholly or partially absent from by far the greater part of the floor of the ocean. In depths greater than 3,000 fathoms we usually met with only a few shells of Pelagic Foraminifera of the larger and heavier kinds; a few hundred fathoms nearer the surface they became more numerous, and we got a few of the smaller kinds and some Coccoliths and Rhabdoliths. At about 1,900 or 1,800 fathoms a few shells of Pteropods and Heteropods are met with; and in all depths less than a mile we have a deposit in which the shell and skeletons of almost every surface organism is to be found. In the equatorial streams and calms the calcareous Algæ, Pelagic Foraminifera, Pteropods, and Heteropods are more abundant in the surface waters than elsewhere; and it is in these same regions that we found their dead shells at greater depths than in the deposits of other parts of the ocean. Another circumstance influences the bathymetrical distribution of these surface shells. When there is a complete and free oceanic circulation from the top to the bottom, these dead shells are found at greater depths in the deposits than where the circulation is cut off by submarine barriers.

The agent by which these shells are removed is, as Sir Wyville

[1] *Zeitschr. für Wissen. Zoologie*, vol. xiii. p. 563.

[2] New Zealand, New Caledonia, and the Seychelles have primitive rocks, if these can be regarded as oceanic islands. Some of the islands between New Caledonia and Australia may have primitive rocks, and the atolls in these regions may be situated on foundations of this nature.

[3] *Proc.* Roy. Soc. Edin., 1876-77, p. 247.

[4] Scrope on "Volcanoes," chap. viii.

[5] The Challengeridæ, and many of the other members of Hæckel's new order *Phæodaria*, certainly live deeper, as we never got them in the tropics except when the net was sent down to a depth of 200 or 300 fathoms.

[1] Among the varieties of Foraminifera recognised by Mr. Brady in the *Challenger* collections, the following have a Pelagic habitat.

Palvinulina Menardii.	*Hastigerina pelagica.*
,, *canariensis.*	*Orbulina universa.*
,, *crassa.*	*Globigerina bulloides.*
,, *Micheliniana.*	,, *æquilateralis.*
,, *tumida.*	,, *sacculifera* (hirsuta).
Pullenia obliquiloculata.	,, *dubia.*
Sphærodina dehiscens.	,, *rubra.*
Candeina nitida.	,, *conglobata.*
Hastigerina Murrayi.	,, *inflata.*

It is the dead shells of these Pelagic Foraminifera which chiefly make up the calcareous oozes of the deep sea. The living shells of all the above varieties swarm in the tropical and sub-tropical waters near the surface. It is especially in the region of the equatorial calms that the largest and thickest shelled specimens are found. As we go north or south into colder water they become smaller, and many varieties die out. In the surface-waters of the Arctic and Antarctic regions, only some dwarfed specimens of *Globigerina bulloides* are met with. The author is unable to agree with Dr. Carpenter and Mr. Brady in thinking that these Pelagic Foraminifera also live on the bottom. This question was made the subject of careful investigation during the cruise. The shells from the surface and from the bottom were compared at each locality, and it was found, by micrometric measurement, that surface specimens were as large and as thick-shelled as any average specimens from the soundings. It is quite unlikely that the same individuals should pass a part of their lives in the warm sunny surface-waters, at a temperature of from 70° to 80° F., and another part in the cold dark waters two or three miles beneath, at a temperature of 30° or 40° F. The geographical distribution of these Pelagic forms over the bottom coincides exactly with the distribution of the same forms on the surface, that is to say, both on the surface and on the bottom the distribution is ruled by surface-temperature. No specimens of these Pelagic varieties were ever obtained from the bottom with the shells filled and surrounded with sarcode. Whereas creeping and attached forms (like Truncatulina, Discorbina, Anomalina, and some Textulariæ) were taken in this condition in almost every dredge. These last-mentioned forms, which we know live on the bottom, have a distribution quite independent of surface-temperature.

Thomson suggested, carbonic acid. Analysis shows that carbonic acid is most abundant in sea-water, and especially so in deep water. Pteropod and Heteropod shells are very much larger than the Foraminifera, yet are very much thinner; and hence, for the quantity of lime contained in them, they present a much greater surface to the action of the sea-water. This seems to be the reason why all large and thin shells are first removed from the deposits with increasing depth, and not the fact that some shells are composed of arragonite and some of calcite, as has been suggested.

There is a continual struggle in the ocean with respect to the carbonate of lime. Life is continually secreting it and moulding it into many varied and beautiful forms. The carbonic acid of ocean-waters attacks these when life has lost its hold, reduces the lime to the form of a bicarbonate, and carries it away in solution. In all the greater depths of the ocean these surface shells are reduced to a bicarbonate either during their fall through the water or shortly after reaching the bottom.

In the shallower depths—on the tops of submarine elevations or volcanoes—the accumulation of the dead siliceous and calcareous shells is too rapid for the action of the sea-water to have much effect. Long before such a deposit reaches sufficiently near the surface to serve as a foundation for reef-forming corals, it is a bank on which flourish numerous species of Foraminifera, Sponges, Hydroids, deep-sea Corals, Annelids, Alcyonarians, Molluscs, Polyzoa, Echinoderms, &c. All these tend to fix and consolidate such a bank, and add their shells, spicules, and skeletons to the relatively rapid accumulating deposits. Eventually coral-forming species attach themselves to such banks, and then commences the formation of

Coral Atolls.—Mr. Darwin has pointed out that "reefs not to be distinguished from an atoll might be formed"[1] on submerged banks such as those here described. However, the improbability of so many submerged banks existing in the open ocean caused him to reject this mode of formation for atolls. As here stated, recent deep-sea investigations have shown that submerged banks are continually in process of formation in the tropical regions of the ocean, and it is in a high degree probable that the majority of atolls are seated on banks formed in this manner.

Mr. Darwin has also pointed out that the corals on the outer margin of a submerged bank would grow vigorously, whilst the growth of those on the central expanse would be checked by the sediment formed there, and by the small amount of food brought to them.[2] Very early in the history of such an atoll, and while yet several fathoms submerged, the corals situated on the central parts would be placed at a disadvantage, and this would become greater and greater as the coral plantations approached the surface. When the coral plantation was small there was a relatively large periphery for the supply of food to the inner parts, and also for the supply of sediment; and hence in small atolls the lagoon was very shallow, and was soon filled up. For the same reasons coral islands situated on long and narrow banks have no lagoons. An atoll one mile square has a periphery of four miles. In an atoll four miles square—the periphery increasing in arithmetical progression and the area as the square—we have for each square mile only a periphery of one mile over which food may pass to the interior, and from which sediment is supplied for filling up the lagoon.

With increasing size, then, the conditions become more and more favourable to the formation of lagoons, and as a consequence we have no large or moderate sized coral islands without lagoons. Tow-net experiments always showed very much less Pelagic life (food) in the lagoon waters than on the outer edge of the reef. The lagoon becomes less favourable for the growth of all the more massive kinds of coral as the outer edge of the reef reaches the surface, and cuts off the free supply of ocean-waters. Many species of corals die.[3] Much dead coral, coral rock, and sediment is exposed to the solvent action of the sea-water. Larger quantities of lime are carried away in solution as a bicarbonate from the lagoon than are secreted by the animals which can still live in it; the lagoon thus becomes widened and deepened.[4]

On the other hand a vigorous growth and secretion of lime takes place on the outer margins of the reef; and when the water outside becomes too deep for reef-forming corals to live,

1 "Coral Reefs," p. 118. 2 "Coral Reefs," p. 134.

3 There are no living corals or shells in some small lagoons, the waters of which become highly heated, and in some cases extremely saline.

4 Complete little Serpula-atolls, with lagoons from 3 to 50 feet in diameter, and formed in this way without subsidence, were numerous along the shores of Bermuda.

these still build seawards on a talus of their own *débris*:—the whole atoll expands somewhat after the manner of a fairy ring.

It is not necessary to call in disseverment of large atolls in order to explain the appearances presented in the Great Maldiva group of atolls.[1] The coral fields rising from very many parts of these extensive submarine banks form atolls. The marginal atolls have from the first the advantage of a better supply of food. They elongate in the direction of the margin of the bank where the water is shallower than to seaward. Many of these marginal atolls have coalesced, and as this growth and coalescence have continued, a large part of the food-supply has been cut off from the small atolls situated towards the interior of the bank. Ultimately a large atoll-like Suadiva atoll would be formed. The atolls in the interior would be perhaps wholly removed in solution, and the atoll-like character of small marginal but now coalesced atolls would be wholly or partially lost by the destruction of their inner sides.[2] A study of the charts shows all the stages in this mode of development.

In the case of the Lakadivh, Caroline, and Chagos archipelagos we have submarine banks at various stages of growth towards the surface, some too deep for reef-forming species of coral, others with coral plantations, but all submerged several fathoms, and scattered amongst these some of the oldest and most completely-formed atolls and coral islands. It is most difficult to conceive how these submerged banks could have been produced by subsidence, situated as they are in relation to each other and with respect to the perfectly-formed atolls, barrier or fringing reefs of the groups.

It is a much more natural view to regard these atolls and submerged banks as originally volcanoes reaching to various heights beneath the sea, and which have subsequently been built up to and towards the surface by accumulations of organic sediment and the growth of coral on their summits. It is a remarkable fact that in all coral atolls which have been raised several hundred feet above the sea, the base is generally described as composed of solid limestone, or "of various kinds of coral evidently deposited after life had become extinct."[3] This base is probably often made up of such a rock as that brought by the missionaries from New Ireland, and described by Prof. Liversidge,[4] as composed chiefly of Pelagic foraminifera, the same as those taken by the *Challenger* in the surface waters of the Pacific.

Microscopic sections of a rock taken from 50 feet below sea-level at Bermuda show that a deposition of carbonate of lime is going on. The small shells are filled with, and the broken pieces of shells and corals are cemented by, calcite. The wells in coral islands rise and fall with the tide, so that the whole atoll is filled like a sponge with sea-water. This water is very slowly interchanged, and by the solution of the smaller and thinner particles becomes saturated, and a deposition of lime follows. In this way we may explain the absence of many of the more delicate shells from some limestones.[5]

Barrier Reefs.—During the visit of the *Challenger* to Tahiti a careful examination was made of the reefs by dredging, sounding, &c., in a steam pinnace, both inside and outside the reefs. Lieutenant Swire, of the *Challenger*, made a careful trigonometrical survey of the profile of the outer reefs on six different lines; and while associated with him in this work the author was indebted to that officer for many valuable suggestions.

A ledge ran out from the edge of the reef to about 250 yards, where we got a depth of from 30 to 40 fathoms. It was covered with a most luxuriant growth of coral bosses and knobs.

Between 250 and 350 yards from the edge of the reef there was generally a very steep and irregular slope; about 100 fathoms was got at the latter distance, and the angles between these last-mentioned distances often exceeded 45 degrees. The talus here appeared to be composed of huge masses and heads of coral, which had been torn by the waves from the upper ledge and piled up on each other. They were now covered with

1 Mr. Darwin's application of his theory to this group—where the disseverment of large atolls is called in, and a destructive power attributed to oceanic currents, which it is very unlikely they can ever possess—has often been considered unsatisfactory.

2 "In speaking of Bow Island, Belcher mentions the fact that several of its points had undergone material change, or were no longer the same when visited after the lapse of fourteen years. These remarks refer particularly to islets situated within the lagoon. I could myself quote many instances of the same description."—"Wilkes' Exploring Expedition," vol iv. p. 271.

3 "U.S. Ex. Exp.," vol. iv. p. 269. 4 *Geol. Mag.*, December, 1877.

5 Fuchs, "Ueber die Entstehung der Aptychenkalke," *Sitzb. der k. Akad der Wissensch.*, 1877.

living Sponges, Alcyonarians, Hydroids, Polyzoa, Foraminifera, &c.[1]

From 350 to 500 yards from the edge of the reef we had a slope with an angle of about 30°, and made up chiefly of coral sand. Beyond 500 yards the angle of the slope decreased till we had at a distance of a mile from the reef an angle of 6°, a depth of 590 fathoms, and a mud composed of volcanic and coral sand, Pteropods, Pelagic and other Foraminifera, Coccoliths, &c.

In the lagoon channel the reefs were found to be fringed with living coral, and to slope downwards and outwards for a few feet, and then plunge at once to a depth of 10 or 16 fathoms. Many portions of these inner reefs were overhanging, and at some places overhanging masses had recently fallen away. Everywhere much dead coral rock was exposed to the solvent action of the sea-water. The reefs of Tahiti are at some places fringing, at other places there is a boat passage within the reef, and at Papiete there is a large ship channel with islets within, and the outer edge of the reef is a mile distant from the shore. The island itself is surrounded with a belt of fertile low land, frequently three or four miles wide; this shows that the island has not in recent times undergone subsidence; there are indeed reasons for supposing it has recently been slightly elevated. Everything appears to show that the reefs have commenced close to the shore and have extended seawards, first on a foundation composed of the volcanic detritus of the island, and afterwards on a talus composed of coral *débris* and the shells and skeletons of surface organisms.[2]

The lagoon channel was subsequently slowly formed by the solvent action of the sea-water thrown over the reefs at each tide, and the islets in the lagoon channel are portions of the original reef still left standing. The reefs have extended outwards from the island and have been disintegrated and removed behind in the same way as the atoll has extended outwards after reaching the surface.

Where reefs rise quite to the surface, and are nearly continuous, we find relatively few coral patches and heads in the lagoons and lagoon channels. Where the outer reefs are much broken up, the coral growths in the lagoon are relatively abundant. Where the water was deep and the talus to be formed was great, the outward growth has been relatively slow,[3] and the disintegrating forces in the lagoons and lagoon channels gaining in the struggle, the reefs would become very narrow, and might indeed be broken up. This, however, would admit the oceanic waters and more food, and growth would again commence on the inner as well as the outer sides of the still remaining portions. In the great barrier reef of Australia, where the openings are numerous and wide, the reefs have a great width. Where the openings are few and neither wide nor deep (as in lat. 12° 30′) the reefs are very narrow and "steep to"—on their inner side.

At the Admiralty Islands, on the lagoon side of the islets on the barrier reefs, the trees were found overhanging the water, and in some cases the soil washed away from their roots. It is a common observation in atolls that the islets on the reefs are situated close to the lagoons. These facts point out the removal of matter which is going on in the lagoons and lagoon channels.

Elevation and Subsidence.—Mr. Darwin has given many reasons for believing that those islands and coasts which have fringing reefs had recently been elevated, or had long remained in a state of rest. Throughout the volcanic islands of the great ocean basins the evidence of recent elevations are everywhere conspicuous. Jukes has given most excellent reasons for believing that the coast of Australia fronted by the barrier reef, and even the barrier reef itself, have recently been elevated.[1] Dana and Conthouy have given a list of islands in almost every barrier reef and atoll region which have recently been elevated.[2]

This is what we should expect. Generally speaking, all the volcanic regions which we know have in the main been areas of elevation, and we should expect the same to hold good in those vast and permanent hollows of the earth which are occupied by the waters of the ocean. It must be remembered that probably all atolls were seated on submarine volcanoes. Areas of local depression are to be looked for in the ocean basins on either side of and between groups of volcanic islands and atolls, and not on the very site of these islands. This is what the deep-sea soundings show if they show any depression at all. Subsidence has been called in in order to account for the existence of lagoons and lagoon channels, and the narrow bands of reef which inclose these; but it has been shown that these were produced by quite other causes—by the vigorous growth of the corals where most nourishment was to be had, and their death solution and disintegration by the action of sea-water and currents[3] at those parts which cannot be, on account of their situation, sufficiently supplied with food.

All the chief and characteristic features of barrier reefs and atolls may indeed exist with slow elevation, for the removal of lime from the lagoons and the dead upper surface of the reefs by currents, and in solution by rain and sea-water, might keep pace with the upward movement.

The most recent charts of all coral reef regions have been examined, and it is found possible to explain all the phenomena by the principles here advanced; while on the subsidence theory it is most difficult to explain the appearances and structures met with in many groups; for instance, in the Fiji islands, where fringing reefs, barrier reefs, and atolls all occur in close proximity, and where all the other evidence seems to point to elevation, or at least a long period of rest. In instances like the Gambier group the reefs situated on the seaward side of the outer islands would grow more vigorously than those towards the interior; they would extend in the direction of the shallower water, and ultimately would form a continuous barrier around the whole group. The distinguishing feature of the views now advanced is that they do away with the great and general subsidences required by Darwin's theory,[4] and are in harmony with Dana's views of the great antiquity and permanence of the great ocean basin, which all recent deep-sea researches appear to support.

Summary.—It was shown (1) that foundations have been prepared for barrier reefs and atolls by the disintegration of volcanic islands, and by the building up of submarine volcanoes by the deposition on their summits of organic and other sediments.

(2) That the chief food of the corals consists of the abundant Pelagic life of the tropical regions, and the extensive solvent action of sea-water is shown by the removal of the carbonate of lime-shells of these surface organisms from all the greater depths of the ocean.

(3) That when coral plantations build up from submarine banks they assume an atoll form, owing to the more abundant supply of food to the outer margins, and the removal of dead coral rock from the interior portions by currents and by the action of the carbonic acid dissolved in sea-water.

(4) That barrier reefs have built out from the shore on a foundation of volcanic *débris* or on a talus of coral blocks, coral sediment, and Pelagic shells, and the lagoon channel is formed in the same way as a lagoon.

(5) That it is not necessary to call in subsidence to explain any of the characteristic features of barrier reefs or atolls, and that all these features would exist alike in areas of slow elevation, of rest, or of slow subsidence.

In conclusion it was pointed out that all the causes here appealed to for an explanation of the structure of coral reefs are proximate, relatively well known, and continuous in their action.

[1] This ledge and steep slope beyond where a depth of 30 or 40 fathoms was reached, was characteristic of a large number of atoll and barrier reefs, and seemed due to wave action. Experiments had been made with masses of broken coral, and it was found that these could (on account of their rough and jagged surface) be built up into a nearly perpendicular wall by letting them fall on each other. A talus formed in water deeper than 40 fathoms, where there was little, if any, motion, would be different from one formed on land. In the latter case the disintegrating forces at work always tended to set the talus in motion; in the former case everything tended to consolidate and to fix the blocks in the positions first assumed. A removal of lime in solution would take place from the blocks forming this steep slope, but except in very deep water this would not be sufficient to check the outward extension of the reef.

[2] A dredging in 155 fathoms, close to the barrier reef of Australia (between it and Raine Island), gave a coral sand, which was, I estimate, more than two-thirds made up of the shells of surface animals.

[3] Hence in barrier reefs, where the depth outside is very great, we find the reefs running closer to the shore than where the depth is less, and consequently the talus to be formed is smaller.

[1] "Voyage of the *Fly*," vol i p. 335.

[2] Dana's "Corals and Coral Islands," p. 345; Couthouy's "Remarks on Coral Formations," *Bost. Journ. Nat. Hist.* See also Stutchbury, *West of England Journal.*

[3] Very strong currents run out of the entrances into lagoons and lagoon channels, and when the tow-net was used in these entrances it showed that a large quantity of coral detritus was being carried seawards.

[4] "We may conclude that immense areas have subsided, to an amount sufficient to bury not only any formerly existing lofty table-land, but even the heights formed by fractured strata and erupted matter."—"Coral Reefs," p. 190.

The author expressed his indebtedness to all his colleagues, to Prof. Geikie, to the Hydrographer and officers of the hydrographic department, and in a special manner to Sir Wyville Thomson, under whose direction and advice all the observations had been conducted.

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THE JAMIN CANDLE

A NEW system in addition to those already prominent in the extensive field of electric lighting is shortly to be introduced into this country in the form of a candle devised by the well-known French electrician M. Jamin. This invention brings with it a considerable reputation, and how far this may be justified we shall probably soon have the opportunity of judging.

It has not yet had a trial in England, and until this is done we can only rely on the results of experiments, apparently of a not very exhaustive or conclusive character, which have taken place in Paris, and which must be accepted with a considerable amount of reservation.

The following description of the new candle is that given by M. Jamin himself in his paper to the French Academy of May 31, 1880:—

"I have had the honour to submit to the Academy during its sitting of March 17, 1879, the principle of a new electric burner.

"I have since succeeded in constructing a practical lamp, which I will describe. It rests on a slate base, which can be fixed into the globes or lanterns, according to the requirements of the decorations, and which supports at the base a gutter of copper, wide, but not very thick, in order to avoid shadows, and at the top is a gutter of soft iron, intended to be magnetised and to attract a movable armature or plate. The alternating current of a Gramme machine passes first through a wire of thin copper folded round the gutter some fifteen or twenty times, and which constitutes the directing circuit. In the middle of this frame and in the same plane are placed the candles or pairs of carbon rods between which the electric arc is to play. There are three, but a larger number can be inserted if the lighting is to be prolonged. Each carbon rod is inserted in a metal socket, in which they stand vertically, point downwards, and are retained in this position by means of a spring.

"The working offers no difficulties and demands no skill. There is no insulating material between the carbons. Those on the right are fixed and vertical; those on the left, hang freely from hinges; the tops of their supports are conected by a small bar, which gives them a movement in common; the armature is attached by a lever to this bar, which it pushes towards the left by its weight, which brings the carbons together until one of them touches its companion. It is to be remarked that the contact will only be made in one of the candles, the longest, or the one whose points hang nearest together; that one will be lighted.

"The electric current, after having traversed the directing circuit, arrives simultaneously at the movable carbons, and can return indiscriminately by the three fixed carbons; it passes between those which touch, and lights them. Immediately the magnetism is made the armature is attracted, the three couples of carbons spring apart at the same time, two remaining cold, and the arc being established in the third. As long as there is any matter to burn it continues maintained at the points by the action of the directing current, and necessarily returning to it if any foreign cause should drive it away. When the current stops the armature falls back, and the contact is re-established; if it passes through again, the carbons are relighted, and spring apart as at first. Thus the lighting is automatic, instantaneous, and renewable at will.

"When the first candle is consumed, another must succeed it. For this purpose the left carbon-holder, which remained fixed, is jointed at the top and can be displaced, not in the plane of the frame, but perpendicularly. It is pushed by a spring, R, which tends to force it away, but it is kept vertical by a wire, B, bent round like a hook at its end, and which slides tightly in a receptacle where a spring presses it. When the combustion of the candle has brought the arc up to this point, the wire is melted, the carbon-holder is released, the two carbons spring suddenly apart, and the arc is extinguished, but immediately relights in the neighbouring candle. The change is so rapid that the action is hardly perceptible, and the other lamps in the same circuit are not at all affected.

"Besides, it must be remarked that this substitution of a fresh candle for the one consumed only happens every two hours, that the wire is only melted at its extremity, that it is sufficient to cut off the point to bend it again and to draw it a little further from its receptacle, when new carbons are to be inserted, and that it serves for a great number of times. One of the greatest inconveniences of electric lighting is the possible sudden extinction of one of the lamps, which immediately causes that of the other candles in the same circuit, although they may be in good condition. Ours are very little subject to this danger, but it must, however, be foreseen and remedied. For this purpose one of my pupils has devised a system, the description of which would be too long. Its effect is (1) to open, at the moment of accident, a secondary circuit, which continues the current across the faulty candle; (2) to replace the extinguished lamp by an equal resistance, which leaves the others in the condition in which they were at first.

"This addition is very important, as it permits of our lighting many or few candles without changing their brilliancy.

"To sum up, our lamp contains many essential qualities. It lights and relights itself as often as required; it only requires one circuit for all the neighbouring candles; it replaces automatically those which are entirely consumed, by new carbons; it employs no insulating material which might alter the colour of the flame; and it requires no preliminary preparation of the carbons, which considerably diminishes the expense. If at first it underwent, like all others, variations of brilliancy that were owing, not to the construction, but to the defective preparation of the carbons, these variations have disappeared since, thanks to M. Carré, to whom so much is already due, and who has just given to his carbons the necessary solidity."

In the summer of 1878 the writer, in conjunction with Mr. McEniry, carried out a series of experiments with various forms of electric candles for Mr. Robert Sabine; the result is embodied in his provisional specification of November 27, 1878, part of which runs as follows:—

"My third improvement in regulating the distance between the carbon electrodes of a regulator or lamp consists in taking advantage of the well-known fact that parallel conductors attract or repel each other according as the currents in them go in the same or in opposite directions. For this purpose I place the carbons vertically side by side, one of them being fixed and the other balanced over a fulcrum or centre. The frames carrying the two carbons form portions of the common electric circuit in such a way that when the current circulates the parallel portions of the balanced frame (which carries the movable carbon) are deflected and the carbons separated. The degree of deflection of the flame depending upon the current, it follows that, should from any cause the electromotive force in the circuit increase, the frame is thereby deflected more, and the electric arc is correspondingly increased in length, which reduces the current again and maintains the light more steadily than when the carbons are placed immovably side by side without any such adjustment."

It is presumed by the writer that M. Jamin's paper to the French Academy of March 17, 1879, explaining the principle of his new candle, was the first public notice of it, and it will be therefore clearly seen that the part of the apparatus which he claims as particularly his own, viz., the directing frame, is in reality due to Mr. Sabine, and that while giving every credit to M. Jamin for independence of thought, it is only in common justice to Mr. Sabine that he should receive the merit of an idea which, in the words of a very flattering notice of the origin of Jamin's candle in a recent number of *La Lumière Electrique*, constitutes an elegant application of Ampère's laws.

Mr. Sabine's arrangement is also of a more simple nature than the candle just described, for it not only regulates the arc but separates the carbons without the aid of magnetism, and this could be as easily accomplished for a combination of three candles as for one.

It is probable that this latter candle was never constructed beyond the experimental stage, but that it could be put into a very simple and practical form is obvious.

Having thus shown that the two systems are identical, we will turn our attention to the consideration of the claims of this particular form of candle as now perfected and brought forward by M. Jamin.

It is questionable whether the surrounding frame of wire is as efficacious as we are led to believe, but that it exerts a certain influence on the electric arc is beyond doubt; but whether this favours the light or acts detrimentally by blowing and expanding the arc remains to be proved. Again, the fact of burning an electric candle point downwards cannot be claimed as anything new, for the candles of Mr. Wilde have been successfully used in this position and without any directing frame. This latter, being of fine wire, must offer a considerable resistance to the current, and cannot be overlooked. It is claimed as an advantage in this system that the leading wires used are of the smallest description even for considerable distances, but the same may be said of any other system where the current-producing machine has a very high electromotive force. The size of wire for the circuit is not dependent upon any particular form of candle or regulator, but upon the current-producing strength of the machine employed for working the system.

The automatic lighting and re-lighting of the Jamin candle shows no advance over the means employed by others, nor does the insertion of a resistance in the place of an extinguished lamp constitute anything new. In any construction of candle where the two carbons are separated by the action of magnetism (one carbon being movable and attached to an armature influenced by an electro-magnet) it is impossible to keep the distances of the carbons apart always constant. Any variation in the current produces a corresponding variation in the magnetism which affects the movable carbon, this being especially the case in using alternating currents where the carbon must necessarily be in a continual state of vibration from the rapid changes of polarity.

Those candles of the Jablochkoff type are free from such a fault, owing to both carbons being made quite rigid by the insulating material between them, and the distance apart, therefore, being invariable throughout the whole length, which conduces greatly to the steadiness of the arc.

It is probable that the brilliancy of the light may be increased by burning the candle point downwards, but it must consume more rapidly than when in the reverse position, as the arc would tend to warm the carbon rods throughout their length. It is however certain that improvements will be made, and that probably this system will eventually compete favourably with others already established, although at present it is difficult to see much advantage over such candles as Wilde's, Rapieff's, &c.

T. E. G.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, August 2.—M. Edm. Becquerel in the chair.—The following papers were read:—On the preparation of chlorine, by M. Berthelot. The formation of the brown soluble compound (preceding the liberation of chlorine) requires not only chlorine and manganese, but a considerable excess of hydrochloric acid; it is a perchlorised chlorhydrate of manganese.—On heats of combustion, by M. Berthelot. This relates to the agreement between Thomsen's results and his own.—Synthesis of hexamethyl benzine and of mellic acid, by MM. Friedel and Crafts.—On human walking, by M. Marey. With his odograph he proves that the step is longer in mounting than in descending for an unburdened man than for one carrying a load, for one with very low-heeled, than for one with high-heeled shoes, for one with a thick sole prolonged slightly beyond the foot than when the sole is short and flexible. It seems as though the heel might be lowered indefinitely with advantage, but soles must not be elongated beyond a certain limit, nor made quite rigid. Sometimes (as in ascending) the length of the step is increased, and the rhythm retarded; at other times (as in more rapid walking) the step both lengthens and is accelerated.—Report on the interoceanic canal project. (Second Part.) M. de Lesseps' documents are approved.—On the gallicolar phylloxera and *Phylloxera vastatrix*, by M. Laliman.—M. Zazareff described a battery in which electricity is produced by passage of a solution of glycerine, under pressure, through a mixture of coke and anthracite.—On the theory of sines of superior orders, by M. Farkas.—Researches on the electric effluvium (silent discharge), by MM. Hautefeuille and Chappuis. M. Thenard's apparatus (with alternative discharges) is well fitted to show the rain of electric fire in various gases. Fluoride of silicium gives the best effects; nitrogen comes next; hydrogen and chlorine also present the phenomenon.—Researches on batteries, by M. D'Arsonval. He indicates two methods of obviating the chemical action which goes on in batteries with two liquids when the circuit is open. The first consists in use of animal charcoal, substituted *e.g.* for the sand in a Minotto battery; the second, in using, as a depolariser, a liquid which gives a precipitate by its mixture with the liquid which attacks the zinc (there are many ways of doing this; and the author mentions some). In the latter case the diaphragm is rendered impermeable by means of a conducting and electrolysable precipitate.—On the optical properties of mixtures of isomorphous salts, by M. Dufet. Let N be the index of the mixed salt, n and n' those of the components, p and p' the numbers of equivalents of the two salts; then $N = \frac{pn + p'n'}{p + p'}$. This law is demonstrated, at least, for sulphates of the magnesian series.—Influence of temperature on the distribution of salts in their solutions, by M. Soret. The concentration of the heated part diminishes, that of the cold increases. The difference grows with the original concentration, and nearly in proportion. In the series of the alkaline chlorides the difference is greater (for the same concentration), the higher the molecular weight of the salt. The phenomenon seems to have no relation to solubility of the salt.—On the rise of the zero point in mercury thermometers, by M. Crafts. This rise (through heating) is quicker and greater in crystal thermometers than in those of glass without oxide of lead; it is quicker at first, and tends to a limit (with heating at fixed temperature). The zero point becomes fixed at the new height, when the instrument is kept at ordinary temperature and the thermometer becomes more stable.—Development, by pressure, of polar electricity, in hemihedral crystals with inclined faces, by MM. Jacques and Curie.—On the pyridic bases, by M. de Coninck.—On the heats of combustion of some substances of the fat-series, by M. Louguinine.—Identity of acute experimental septicæmia with the cholera of fowls, by M. Toussaint.—Formation of new races; researches in comparative osteology, on a race of domestic oxen observed in Senegambia, by M. de Rochebrune. The animal—a zebu—is specially distinguished by a conical nasal horn.—Action of poison on cephalopoda, by M. Yung. The effects of curare, strychnine, nicotine, &c., are described.—On a hailstorm at Paris on July 30, 1880, by M. Ferrière.—On determination of crystallisable sugar in presence of glucose and dextrine, by M. Pellet.

VIENNA

Imperial Academy of Sciences, July 1.—The following, among other papers, were read:—Development and formation of the glands of the stomach, by Prof. Toldt.—Tuberculosis, by Prof. Heschl.—On the absorption of radiant heat in gases and vapours, by Herr Lecher and Herr Pernter.—On an optical property of the cornea, by Prof. Fleischl.

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