THURSDAY, FEBRUARY 15, 1877

DARWIN ON FERTILISATION

The Effects of Cross- and Self-Fertilisation in the Vegetable Kingdom. By Charles Darwin, M.A., F.R.S., &c. (London: John Murray, 1876.)

FEW as are the students of vegetable physiology in this country, it is very far from a mere boast to say that, with Mr. Darwin's aid, we have no reason to shrink from comparing English work in this subject with that done abroad. Mr. Darwin has sometimes lamented that he is not a botanist, yet it would be difficult to name any scientific man with an accepted claim to that description who could point to more valuable botanical work than his studies of heterostyled plants, the fertilisation of orchids, and the habits of climbing and insectivorous plants. As to the present volume, there is no risk whatever in stating that it at once takes and will always retain a classical position in botanical literature. And when one considers that these are not the only things which have come during late years from the same apparently inexhaustible treasury, and when one remembers also that the great student who has filled it has throughout struggled with difficulties which would have effectually quenched the energy of most men, one may allow oneself to wonder whether Mr. Darwin's own scientific activity is not itself a more than remarkable biological problem.

There can be no doubt that the publication of the present work is extremely opportune. An enormous body of observations, of which a great part have been brought together by Dr. Hermann Müller, have solidly confirmed the well-known induction stated by Mr. Darwin in 1862, that "nature abhors perpetual self-fertilisation." Most persons who have studied the subject have been satisfied that the facts safely covered the conclusion that the varied adaptive contrivances in flowers really had for their object the prevention of self- and the promotion of cross-fertilisation, even if nature chose to preserve an impregnable silence as to the reason of her abhorrence of the former process. There have not, however, been wanting those who have attempted to explain away the significance of all that had been stated. Not seeing the mischief of self-fertilisation, they have hastily assumed that it had none, and thence have arrived at the conclusion that the cause of the adaptive modification of flowers must be sought for elsewhere.

At any one period the area of knowledge is always bounded by a wall too high to see over, and against which it is easy but not profitable to bruise one's head. It is difficult to say whether it requires more genius to scale the wall at one dash or to pass out by the doors which are everywhere provided for those with eyes to see them. And though no one would have the rashness to suggest that there was anything defective in Mr. Darwin's scientific vision, yet there is some comfort to be derived from the fact that he gives from his own experience a most instructive instance of the real difficulty that even the greatest of investigators may feel in emancipating himself from the limits which prepossession—conscious or unconscious—constantly opposes to the progress of research. Without, of course, having a shadow of doubt that nature had some need to satisfy in so laboriously struggling to prevent self-fertilisation in plants, Mr. Darwin was content to suppose that it might be injurious in the long run, in some way difficult, at present—if ever—to be analysed, and, to use his own words:—

"That it would be necessary, at the sacrifice of too much time, to self-fertilise and intercross plants during several successive generations in order to arrive at any result. I ought [he continues] to have reflected that such elaborate provisions favouring cross-fertilisation, as we see in innumerable plants, would not have been acquired for the sake of gaining a distant and slight advantage, or of avoiding a distant and slight evil" (p. 8).

In fact an observation almost accidental led the way to the remarkable discoveries recorded in the present volume. Of these an article in the *Academy* (August 28, 1875) by Mr. George Darwin gave, I believe, the first intimation, and raised in the highest degree our expectations. "My father," he stated, "has now been carrying on experiments for about nine years on the crossing of plants, and his results appear to him absolutely conclusive as to the advantages of cross-fertilisation to plants." Mr. Darwin informs us that he was led to the investigation by the manifest contrast presented by "two large beds of self-fertilised and crossed seedlings from the same plant of *Linaria vulgaris*" (p. 9), in which he found to his surprise that "the crossed plants when fully grown were plainly taller and more vigorous than the self-fertilised ones." His "attention was now thoroughly aroused," and two-thirds of the present volume are devoted to the very extended course of experimentation, the results of which Mr. Darwin puts forward in confirmation of the conclusion which his first and accidental observation suggested. These results deserve and will receive the most careful study at the hands of botanists, but it would be scarcely useful within the limits of this notice to examine them in any detail. They appear, however, to me, to demonstrate completely the advantage which cross-fertilised plants obtain in all that concerns their struggle for life—in increase of size, of bulk (as measured by weight), and of fertility, as well as in precocity of flowering and capacity of resisting adverse external influences.

The remainder of the volume is, however, occupied with general discussions, upon which it may be interesting to make some remarks. The process of gamogenesis essentially consists in "the physical admixture of protoplasm derived from two sources." Mr. Darwin's investigations have left no room for even a shadow of a doubt that the object of nature in bringing about this result is to secure for the starting-point of the new organism a protoplasmic mass made up of elements which have been independently individualised or differentiated by exposure to different external conditions. Mr. Herbert Spencer explains this by the need which the manifestation of life involves for continually disturbing the condition of molecular equilibrium to which all things in nature gradually tend. But as Mr. Darwin hints, this mode of explanation scarcely does more than restate the empirical facts which we may now sum up by saying that for gamogenesis to give the best result a certain mean differentiation—vary-

ing much for different organisms—in the sexual elements which take part in it is necessary. And in so far as Mr. Spencer's theory suggests an analogy to chemical change, it is perhaps leading us away from the direction of real explanation altogether.

The use of the phrase "mean differentiation" perhaps conveniently expresses Mr. Darwin's ingenious and most probable correlation of the facts of hybridisation with those of self-fertilisation.

"It is an extraordinary fact that with many species, flowers fertilised with their own pollen are either absolutely, or in some degree, sterile; if fertilised with pollen from another flower on the same plant they are sometimes, though rarely, a little more fertile; if fertilised with pollen from another individual or variety of the same species, they are fully fertile; but if with pollen from a distinct species, they are sterile in all possible degrees until utter sterility is reached. We thus have a long series with absolute sterility at the two ends; at one end due to the sexual elements not having been sufficiently differentiated, and at the other end to their having been differentiated in too great a degree, or in some peculiar manner" (pp. 455, 456).

In this mode of regarding phenomena which at first hardly seem to have anything in common, and embracing them under a single "expression," there is a neatness quite mathematical. Mr. Darwin admits, however, with characteristic frankness that in thus breaking down the fundamental difference between species and varieties, he traverses a prejudice which "it will take many years to remove" (p. 467).

But it is possible to go even further and regard gamogenesis and agamogenesis themselves as particular cases of a generalised process. Every organism, whether sexually produced or not, may be regarded as an aggregate of cells derived from a single mass of protoplasm which has undergone repeated division. Fertilisation, as Prof. Huxley has remarked,[1] is only "one of the many conditions which may determine or affect that process." And this remark probably supplies the explanation of the undoubted fact that amongst flowering plants as in every other part of the vegetable kingdom, there is every gradation between plants which are simply incapable of self-fertilisation and therefore would die out if they were not perpetually crossed, and others in which self-fertilisation is the rule.

"Some few plants, for instance, *Ophrys apifera*, have almost certainly been propagated in a state of nature for thousands of generations without having once been intercrossed; and whether they would profit by a cross with a fresh stock is not known. But such cases ought not to make us doubt that, as a general rule, crossing is beneficial, any more than the existence of plants which in a state of nature are propagated exclusively by rhizomes, stolons, &c. (their flowers never producing seeds), should make us doubt that seminal generation must have some great advantage, as it is the common plan followed by nature" (p. 439).

Still there is room for believing that nature may be able to give more or less freely to plants, but in some other way, those benefits which gamogenesis, especially in its more differentiated forms, undoubtedly confers. It may be one of nature's favourite expedients, and yet not the only one. It is highly important to bear this in mind and to keep clearly in view what it is exactly that Mr. Darwin has done. He has explored, and in a manner which had never been attempted, much less accomplished before, the precise utility of cross-fertilisation, and has consequently given enormously increased force to all arguments drawn from the adaptive arrangements that promote it by demonstrating their extreme urgency. But he has not tied nature's hands to doing her work with this implement alone, and therefore he is not open to the objection which some persons will probably urge, that cross-fertilisation cannot be so important, seeing that many plants get on apparently very well without it. This is, indeed, as if one were to argue that the printing-press cannot have had the influence attributed to it, seeing that there have been those who expressed their meaning excellently well with the help of the fore-finger and some sandy soil.

The evidence which Mr. Darwin has collected leads almost irresistibly to the conclusion that the benefit derived from gamogenesis does not depend upon any mysterious property inherent in the process itself, but that "change" is to be regarded as at the bottom of the benefit derived from it; intercrossing, in fact, ceases to be beneficial if the plants crossed have been for many generations exposed to the same conditions. The advantage is, in fact, of the same kind as that which all organisms seem to derive from "an occasional and slight change in the conditions of life." "But the offspring from a cross between organisms which have been exposed to different conditions [and therefore differentiated] profit in an incomparably higher degree than do young or old beings from a mere change in their conditions" (pp. 454, 455), and the reason is that "the blending together of the sexual elements of two differentiated beings will affect the whole constitution at a very early period of life, whilst the organisation is highly flexible." But as change may be of the most variable amount, the corresponding differentiation may be equally variable. In some cases it must be exceedingly small; amongst the *Conjugatæ*, for example, in *Rhynchonema*, two adjacent cells of a filament unite by small lateral processes which bridge over the intervening septum. And the bridge being very narrow, one cell is forced to become the recipient of the contents of the other and the sexual differentiation of the two conjugating cells is thereby established. In *Vaucheria*, where the protoplasm is continuous through the whole vegetative portion of the filamentous organism, the sexual organs are formed by small adjacent processes which are merely parted off from the common protoplasm of the filament which bears them. This must also be an extremely close case of self-fertilisation, but as fertilisation is effected by motile antherozoids, there is a remote possibility of an occasional cross. The hermaphrodite condition in such cases may easily be conceived to have been developed from a stage in which conjugation alone obtains.

It would not be difficult to show that all through the vegetable kingdom the hermaphrodite condition precedes the diœcious. Thus in ferns where the sexual organs are developments of epidermal processes on the peculiar intermediate generation known as the prothallium, there is almost every condition which is met with in flowering plants. The female organs (archegonia), however, require more than one layer of cells for their ultimate development, and are consequently matured later than the male organs (antheridia). Hence ferns tend to be proterandrous and therefore functionally diœcious; and as it fre-

[1] "Encylcopædia Britannica," Art. Biology, p. 687.

quently happens that the young prothallium gets arrested in its development without reaching the stage in which archegonia are produced, such prothallia will be exclusively male by arrest of development. It can hardly be doubted that in an analogous manner male flowers have arisen in diclinous flowering plants. In *Osmunda* amongst ferns the complete diœcious condition is reached. There can, in fact, be no doubt that ferns are habitually cross-fertilised, and there is also good reason to believe that they are even hybridised. It is further noteworthy that whilst in *Osmunda* there is an agamic reproduction of the prothallial generation, in a few rare cases, as pointed out first by Dr. Farlow, the process of gamogenesis is wholly in abeyance and the prothallium gives rise to the spore-bearing stage agamogenetically. One might remark here that the probable absence of true gamogenesis amongst the larger fungi might be compared with this abnormal occurrence in ferns. But another explanation suggests itself. Amongst the *Myxomycetes* the continuous masses of protoplasm which constitute the plant in its active state, segregate into spores which eventually set free zoospores. These swim about to again coalesce into a plasmodium. Sachs has suggested that this coalescence is of a sexual character, and in fact a kind of multi-conjugation; and no doubt the zoospores, in their motile condition, will undergo a certain amount—inconceivably minute it may be—of differentiation, due to slight differences in exposure to external conditions such as heat and light, and thus the end of a more regular sexual process may be attained. In the higher fungi there is nothing exactly comparable with this unless we compare with the fusion of zoospores in the *Myxomycetes* the habitual inosculation and intergrafting of the mycelial threads, the result of which must be to bring about an intermixture of somewhat differentiated protoplasm.

Perhaps, therefore, on a review of Mr. Darwin's remarks on the subject of hermaphroditism (pp. 409, 410), one may demur to his conclusion that the monœcious condition "is probably the first step towards hermaphroditism." It seems not improbable that precisely the converse may be the more true. Mr. Darwin thinks "that as plants became more highly developed and affixed to the ground they would be compelled to become anemophilous in order to intercross. Therefore all plants which have not since been greatly modified would tend still to be both diclinous and anemophilous." But it does not appear that it is intended to limit this statement to flowering plants; yet it would certainly require some modification amongst *Pteridophyta* for example. As we have seen, ferns, at any rate, are not diclinous, nor are they anemophilous, yet they escape all the evil results possibly attending the hermaphrodite condition. The fact is that as long as plants possess motile antherozoids, and their sexual processes take place not in mid-air, but on damp soil, there is no need for the intervention of agencies like the wind or insects to bring about cross-fertilisation. The natural locomotive powers possessed by the antherozoids are sufficient to secure that. The difficulty began when the very limited mobility of the pollen tube was substituted for the amazing activity of the antherozoid. And it will throw a great deal of light on the question as to whether the primordial flower was diclinous or not if one considers the manner in which it probably originated.

In the first place, it must be remembered that the processes which take place in a "flower" are, in a vascular cryptogam, spread over two distinct generations. The drama which once had two acts is now compressed into one. Bearing this in mind, we shall find little difficulty in seeing in the sporangiiferous cone or spike of *Selaginella* the homologue of the flower. For, like that, it is composed essentially of an axis bearing modified lateral appendages, some of which, in this case the upper ones, produce male structures—microspores—and the lower—female ones—macrospores. These bodies fall to the ground, and those from adjacent plants are more or less commingled by the wind before sexual interaction begins to take place. Now, comparing a flower, we find that it also consists of an axis with modified lateral appendages, and if we call the embryo-sac a macrospore and the pollen-grain a microspore, as we are thoroughly justified in doing, then the only important difference between a "*Selaginella*-fructification" and a "flower" is that the position on the axis of microspore- and macrospore-producing structures is inverted.

How, then, do we proceed from one to the other? Simply by prolonging the period during which microspores and macrospores remain attached to the parent plant. Instead of fertilisation being effected on soil moist enough to allow the antherozoids to move, suppose it take place on the parent plant in a comparatively dry atmosphere. Antherozoids are no longer set free by the microspore, which simply puts out processes (of which those from the microspore of *Salvinia*—forming the very rudimentary male prothallia—are a kind of foreshadowing) towards the female organs developed from the macrospore. And there is precedent, for example, amongst the *Saprolegnieæ*, for such a reversion to a mode of fertilisation resembling conjugation (which fertilisation by a pollen tube really is) from a phase of motile antherozoids.

There is a probability, then, that a flower originated by the retention of macrospores (more especially) within the structures of some plant-form not distantly related to *Selaginella*—such a flower would be extremely inconspicuous, destitute of colour—these modifications being only subsequently acquired—and, what is more important, hermaphrodite. Diclinous flowers would arise simply by the arrest of development of either the male or female organs, and this arrest would be only one of the several modes by which nature determines the cross-fertilisation which we now know to be beneficial, and therefore likely to be secured by the self-adjusting process of natural selection. This view, by which flowers are regarded as originally hermaphrodite, instead of, as Mr. Darwin suggests, monœcious, further supplies a very simple explanation of the otherwise almost inexplicable nature of cleistogene flowers. These being inconspicuous and self-fertilising—are probably survivals of the original type.

I am happy to be able to support what I have urged by the following passages from Mr. Bentham's presidential address to the Linnean Society in 1873. Criticising Strasburger's views as to the pedigree of phanerogams (which derived them from the diclinous Conifers), he remarks that if we accept them,

"We must suppose that races, after having once secured the advantages of a total separation of the two

sexes and undergone modifications suited to their separate requirements, have again returned to their primitive state of sexual proximity, and commenced a totally different series of modifications destined to counteract the evil effects of that proximity. A much more simple hypothesis would be that Conifers separated from the parent stock before the development of floral envelopes, *the higher Dicotyledons before the separation of the sexes*."

The anemophilous fertilisation of the arborescent plants of cool countries is perhaps rather a climatic adaptation than a survival of a primitive condition, while the cases, of which many have been recorded, in which diclinous plants have produced hermaphrodite flowers—such as the papaw and pitcher-plant in the Glasnevin Botanic Garden described by Dr. Moore—would be easily explicable as the results of atavism, *i.e.*, of reversion to a former hermaphrodite condition. On the other hand Mr. Darwin's suggestion (p. 410) that "if very simple male and female flowers on the same stock each consisting of a single stamen or pistil, were brought close together and surrounded by a common envelope, in nearly the same manner as with the florets of the *Compositæ*, we should have an hermaphrodite flower," offers very considerable morphological difficulties. As a further argument that the flower originates like the fructification of *Selaginella*, by the sexual specialisation of adjacent lateral appendages, one may point out that the early stages in the development of macrospores and microspores are indistinguishable, while in flowering plants there is a reminiscence of this in the case of ovules occasionally being polleniferous.

Difficult as it is to resist discussing the suggestions which everywhere present themselves in this most interesting book, the limits of a review compel me to stop. I will merely point out that here, as in so many cases, investigations undertaken from a purely scientific point of view are not without their practical utility. The precise conditions which Mr. Darwin has ascertained as sufficient to fix in a fleeting variety any particular quality, will be of the last importance in the hands of cultivators.

Just two centuries before the date of this book Sir Thomas Millington, at Oxford (1676), laid the foundation of this branch of investigation by assigning to pollen on theoretical grounds its hitherto unknown function. This it only remained for Bobart, in the Oxford Physick Garden, to experimentally verify (1681). Science is the property of no nation, nevertheless one may feel some pride that the first and the last of the capital discoveries that have been made in respect to plant fertilisation belong to Englishmen.

W. T. THISELTON DYER

OUR BOOK SHELF

Bulletin des Sciences Mathématiques et Astronomiques. Tome dixième. Mars-Juin, 1876. (Paris: Gauthier-Villars.)

WE have no mathematical publication in this country covering quite the same ground as this admirable *Bulletin*. Indeed we hardly think such a journal could survive the issue of half-a-dozen numbers here. The late Mr. T. T. Wilkinson, in an interesting series of notices of "Mathematical Periodicals," points out that such periodicals have "formed a distinguishing feature in our scientific literature for upwards of a century and a half," and quotes a remark of Prof. Playfair (*Edinb. Rev.*, vol. xi.) to the effect that "a certain degree of mathematical science, and, indeed, no inconsiderable degree, is, perhaps, more widely diffused in England than in any other country of the world." These observations have reference principally to such journals as the *Lady's and Gentleman's Diary*.

A very limited circulation, we fear, rewards the editors of the *Quarterly Journal of Mathematics* and the *Messenger of Mathematics*. Nor do we think the state of things would be greatly altered if such a publication as the one before us were started here. The division is mostly a triple one— a review, or reviews, of new mathematical works, followed by an analysis of the contents of current mathematical publications, occasionally supplemented by an original paper.

In the March number we have a long account of Dr. Lindemann's edition of Clebsch's "Vorlesungen über Geometrie" (ersten Bandes erster Theil), a review of Rear-Admiral Sands's "Astronomical and Meteorological Observations" (1871, 1872), an analysis of Dr. Günther's "Lehrbuch der Determinanten—Theorie für Studirende." We have also in this and the other numbers descriptions of the contents of Bellavitis' *Rivista di Giornali*, Catalan and Mansion's *Nouvelle Correspondance Mathématique*, *Mathematische Annalen*, *Giornale di Matematiche*, *Monatsberichte*, and like periodicals. Just noticing the interesting discovery that the Gaussian logarithms (logarithmes d'addition et de soustraction) were first treated of by Leonelli (Avril No., p. 164), his work having been translated into German in 1806, and Gauss having published his table in Zach's *Monatliche Correspondenz* in 1812, we pass on to two notices of mathematical histories. M. E. Hoefer's "Histoire des Mathématiques, depuis leurs Origines jusq'au Commencement du XIX^{e} Siècle" (Mars No.), comes in for strong condemnation. At the end of the critique we read "nous terminerons cette analyse en exprimant le désir de voir bientôt paraître dans notre langue un ouvrage sur l'histoire des mathématiques, écrit par un mathématicien avec tout le soin que réclame une tâche aussi difficile, et s'adressant, non à *tout le monde*, mais à ceux qui ont intérêt à connaître cette histoire et que leurs études mettent à même de la comprendre." The importance of Hankel's "Zur Geschichte der Mathematik im Alterthum und Mittelalter" in the eyes of the editor may be gathered from the fact that the notice of it takes up thirty-four pages out of the forty-eight. Judging by the extracts and comments the work is one of much research, originality, and interest. "Tel est le résumé bien incomplet du remarquable volume dont nous avons cherché à rendre compte. Nous espérons que ce que nous venons de dire suffira pour engager tous ceux qui s'intéressent à la science à lire le livre de Hankel, et pour en faire désirer une traduction dans notre langue." Is it too much to hope that now we have living amongst us a mathematician whose "great historical treatises are so suggestive of research and so full of its spirit" this country will produce a work to rival M. Hankel's? If it is too much to expect then we hope some one will do for us what the writer in the *Bulletin* desires for his own country.

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 Obsidian Cutlers of Melos

DURING a tour in Greece in the past summer I obtained a small number of stone implements chiefly from the Island of Kythera (cerigo) and the Isthmus of Corinth, consisting of a few corn-crushers or pounders, and some celts. The latter are particularly clumsy and very thick in section, and are usually a beach or torrent pebble of suitable form ground to a cutting edge, and sometimes roughened by pecking at the other extremity, as if to afford a firmer grasp for the hand. Their shape

makes them unsuitable for insertion into a handle except where the implement is small, and here the roughening is absent. I also obtained a large number of the obsidian cores and flakes from the Island of Melos, which are familiar to most collectors. It is on these latter objects that I shall make some observations.

On examining a series of these flakes I found a small number of them which presented a singular wavy pattern down the back ridge, which has evidently been produced by alternate pressure, or a series of taps administered by some small instrument like a punch.[1] I have since procured some more cores and flakes with the view of examining the question more carefully, and have been fortunate in securing some interesting evidence from them. Out of a total of 230 obsidian flakes examined I have found 39 which have this marking with more or less distinctness. In many cases the working is extremely rude, the alternate chipping wide, straggling, and uneven, and the depth of the depression and general character of the fracture such as to suggest considerable violence in the blows which produced it. In other cases the chipping is flatter and shallower, but still not very even. But in a very few choice specimens the chipping is so even and regular as to produce a pattern not unworthy of the manufactures of some of the "crimped" Danish daggers.

On examining a series of small cores I was delighted to find on a few of them traces which leave no doubt that this curious marking was produced *before* the flake was detached from the core. In addition to the beautiful parallel fluting for which the Greek cores are remarkable, I have found one ridge in some of the cores (in 22 out of 125) worked up into the serrated edge and ready for the blow which should have detached the flake. I have only had the good fortune to find in one instance a flake still *in situ* on its core whose chipping will compare with the best specimens in my possession of detached flakes. Indeed on some of the cores the working is so rude as to form merely a jagged and irregular line instead of the beautifully clean ridge of the ordinary flaking; and without the evidence of the other flakes and cores, I should not have been able to interpret the intention of these ruder specimens.

There is another form of working to be observed on a certain number of the obsidian flakes. They have in many cases, by a series of very delicate and flat chippings, had their back ridge so modified or removed as to present a blade-like surface. In some cases this extends over the whole of the back of the flake, in others (where it has been a double-ridged flake) the chipping is merely enough to remove one ridge, making a blade like one of our own dinner knives, thinner at the cutting edge than on the blunt back. The intention in this case is very evident, being merely to increase the cutting powers of the flake by removing all impediments. Here again the chipping was effected while the flake was still *in situ*. I have two or three cores with one side flattened by the removal of several ridges, and awaiting conversion into a knife-blade by a blow which never descended.

The use, however, of the flakes with the serrated back ridge, is more questionable. It is, I think, not possible to suppose that the working in this case was put there as a mere piece of ornamental cutlery, although the similar crimping on the Danish daggers was certainly so. In the best Melian flakes the working is certainly highly ornamental, but such specimens are somewhat exceptional, and in the majority of instances the working cannot be considered ornamental at all, and evidently does not aim at nicety and symmetry. Hence we may reasonably conclude that the purpose of the working was utility in the first instance, and ornament only incidentally. I think there is little doubt that these serrated flakes were manufactured to serve the double purpose of a knife and a saw (rasp, or file), and they would be by no means inefficient tools in experienced hands.

I am not aware that attention has been called to these peculiarities of the Greek obsidian flakes—or indeed that they have been hitherto observed at all: and I have therefore thought it worth while to offer some account of this interesting instance of obsidian manufacture. I am not aware that any similarly worked flakes have been discovered in Mexico; and I should be much interested if any of your readers could correct me on this point.

It is worth remarking that there are several qualities of Greek obsidian. The blackest and most beautiful is glossy and lustrous, but will by no means compare with the obsidian of Mexico in these particulars. Greek obsidian has nearly always an undertone of opaque green. There is, however, a quality which is a dull leaden grey, slightly lustrous only, and less vitreous in its composition. It breaks with the same fracture as the more lustrous qualities.

When the flake is trimmed very fine, it is frequently transparent, and if held to a strong light presents a beautiful grey and black "brindled" texture.

The Greek cores are all of small size, the longest which I have seen being just under three inches; but I have one flake which measures $3\frac{3}{8}$, and a few which vary between that and three inches. One most exceptional specimen, however, which is quite unlike any of the others, and is weathered on both sides, measures $4\frac{1}{2}$ inches by $1\frac{5}{8}$ broad, has a rough central ridge, a large bulb of percussion, and is in sectional thickness $\frac{3}{4}$ inch. I have some shorter fragments approaching the same character.

It will not have escaped the notice of many readers that Dr. Schliemann found a number of obsidian "blades" (flakes, no doubt) in one of the last opened of his tombs at Mykenæ, together with twenty-five arrow-heads of flint. Future discoveries in Greece will furnish additional proofs of the general use of this material in early times, and I have little doubt that Melos served as the "Sheffield" of Greece, in the obsidian trade. I had myself the fortune to pick up a small fragment of the substance amongst the ruins of Tiryns.

I have placed the series of flakes, cores, &c., in Charterhouse Museum, where they can be seen by anyone who is interested in them.

GERALD S. DAVIES

Charterhouse, Godalming

[1] Mr. John Evans, to whom I showed one of these, is of opinion that the marking has been produced in the second of the two ways suggested, viz., by blows administered by a small set or punch.

Ocean and Atmospheric Currents

IN a clever article in the *Quarterly Review*, on the geographical and scientific results of the Arctic expedition, which I have read with great interest, the following passage occurs:—"The polar streams flow southward as surface-currents as long as they remain under the influence of northerly winds. When they reach the region of south-westerly winds they disappear under the warm waters of the Gulf Stream. And this for the simple reason that in each instance the stream, as Sir George Nares says, will take the line of least resistance. In the case of a stream going before the wind, this will be on the surface; when going against the wind, the line of least resistance will be some distance below it."

It is certainly very clever of ocean currents to dip below the surface, when they meet with a foul wind, but that they do so requires proof, especially as the warm current in the North Atlantic, bound presumably from the equatorial to the North Polar regions, makes a detour all along the north coast of South America, deflected by the north-east trade when it might apparently have accomplished its purpose so much more directly by the simple expedient of dipping beneath the surface. I would beg to suggest that the disappearance of the polar streams under the warm waters of the Gulf Stream, as indicated by the writer in the *Quarterly*, is to be accounted for in a far simpler manner, viz., because owing to the high temperature of the Gulf Stream in the latitude where this particular phenomenon takes place, it is lighter than the fresher but far colder water of the polar stream.

While I regret to differ from Sir Geo. Nares, backed by so great an authority as Mr. Croll, I must question the possibility of wind piling up water to any great extent either on the surface of the open ocean, or even in more confined water, of either great or uniform depth, as the water will, under those circumstances, re-establish its equilibrium by running off below the surface.

We know that in both the polar and equatorial basins, we have large volumes of water constantly running in at the bottom, or in case some of my readers may disagree with me, with reference to the polar basins, I will put it more guardedly, and say at some distance below the surface; these currents must displace on the surface a body of water exactly equal to their own volume, and this body of water must necessarily run off in that direction in which it meets the least resistance. For the sake of brevity I leave out the consideration of evaporation and precipitation, which bear a very small proportion to the large volume of these currents.

I have in a previous paper pointed out that "Heavier water flowing continuously from a higher level (*i.e.*, in the case of the ocean from the surface) into the bottom of any basin of lighter water must displace and raise a body of water equal to its own volume. The lighter water will just as surely be lifted and buoyed upwards by the heavier water as a ship, a piece of cork, or any other substance having a less specific gravity than water, and when

this lighter water is raised above the level of its own basin it will naturally flow off in the direction in which it meets the least resistance."

To conclude, I argue that while the wind undoubtedly influences the direction taken by ocean currents, difference of gravity, and not wind, is the principal promoter of them. The perfect agreement between the two systems of ocean and atmospheric currents alluded to in the *Quarterly* is, in my opinion, to be accounted for from similar causes producing similar effects.

How can the winds influence ocean currents running for thousands of miles below the surface, or how can they influence the direction of the lower strata of surface currents ranging say from 50 to 600 feet in depth, the latter being the depth of the Gulf Stream off Hatteras? DIGBY MURRAY

January 25

MR. DIGBY MURRAY (vol. xv. p. 294), in common with a great number of meteorologists, maintains that the surface-trades have come, as upper-currents, from the Arctic and Antarctic regions, and that the prevailing westerlies of the extra-tropical regions have come, as upper-currents, from the equator, without intermingling their volume in the district of the tropical calms.

He argues that this *must* be the case, because the surface-trades on the interior borders of the tropical calms differ from the westerlies on the exterior borders in their degrees of electricity, and of saturation, and in other particulars.

I regard this argument as incontestably sound, provided always that no objection can be taken to the assumption on which it rests. That assumption may thus, as I conceive, be fairly stated: "Atmospheric currents differing greatly in character must have travelled from widely distant regions of the globe."

This premise is plausible, and the objection which I have to offer to it rests upon a fact which is, unfortunately, obscure, and which has received very little attention.

Some light is frequently thrown on the more general and permanent atmospheric circulation of our globe by the analogy of the local and temporary systems of circulation which we examine in our own latitudes. Now the *most local* currents often differ very remarkably in character according to the direction in which they move: *e.g.*, the easterly winds felt on the south border of a small anticyclone, if pursued for a very limited distance into the district in which they begin to travel from the south, are often found to have undergone complete change in their electrical conditions, in the aspect of the clouds which they carry, in their humidity, in their amount of ozone, and finally even in their effects on the animal frame. Still more extraordinary are the alterations often noticeable in the different segments of very local cyclonic circulations. In the case of the smallest secondary depressions I have, very frequently indeed, been struck by the wonderful alteration in the several atmospheric conditions, and especially by the reversal of the electrical conditions, which immediately attends the springing up of a northerly breeze, when the barometric minimum has passed to the east. This breeze, in many of these examples, occupies a very short as well as very narrow belt, and is only of a few hours' duration. What is more important, it is usually *of very limited depth*. The synchronous upper-current observations at which I have been for some years at work, prove that in many instances of very local depressions the cirrus travels from southerly or westerly points for many hundred miles on all sides of the small depression, as well as immediately over it, in some cases very slightly affected, in others absolutely unaffected, by the limited circulation at the earth's surface.

Until therefore it can be shown (in contradiction to what is indicated by this fact) that our most local currents, if differing in character, have travelled to us at a great elevation from very high and very low latitudes respectively, I cannot hitherto regard Mr. Digby Murray's reasoning as furnishing an "absolute proof" of the soundness of his position.

From Mr. Murphy's criticisms on my former argument I do not retire, as Mr. Digby Murray may possibly complain that I have done from my discussion with himself, behind a veil of cirrus, after the convenient fashion of the Homeric heroes. But as I have already stated, my agreement with his view that "the imperfection of the Arctic as compared with the Antarctic depression is due to the amount of land in the northern hemisphere" (though differing from him as to the nature of the relation between the cause and the effect), it is perhaps hardly necessary for me to say that from his proposition in NATURE (vol. xv. p. 312) I am bound to dissent. I do not think that on Mr. Murphy's hypothetical globe, possessed of an atmosphere containing no aqueous vapour, the currents would "act as in our actual atmosphere," or in a manner at all analogous to that which he describes. On this point I am afraid we must agree to differ for the present. W. CLEMENT LEY

February 7

Auroric Lights

HAVE the auroric lights been studied in regard to their relations with changes in the weather? From casual observations made during the last twenty years it would appear that there are at least two distinct kinds of light so classed. One is brilliant and transparent, of a white, yellowish, bluish, or yellowish-red colour; while the other is semi-opaque and of a bloody red colour. The latter generally seems to be considered in Ireland a forerunner of bad weather, or, to quote a Connemara shepherd, "Them bloody lights are bad." The first kind generally appear as intermittent pencils of light, that suddenly appear and suddenly disappear. Usually they proceed or radiate from some place near the north of the horizon; but I have often seen them break from a point in the heavens, this point not being stationary but jumping about within certain limits. The brilliant aurora of September, 1870, was one of the latter class, except that the centre of dispersion was not a point, but an irregular figure, sometimes with three sides, but changing to four and five-sided. It began as rays near the north horizon and proceeded up into the heavens in a south-south-east direction. Sometimes, however, these lights occur as suddenly flashing clouds of light, like those of July 16 last, which were of a white colour; but at other times I have seen them of blue and reddish yellow. If this class of lights are watched into daylight they appear somewhat like faint rays of a rising sun. One morning while travelling in West Galway, in the twilight, they were very brilliant, and quite frightened the driver of the car, who thought the sun was going to rise to the north instead of at the east.

The second, or bloody-red light, usually occurs in clouds floating in one direction up into the heavens, but often depressed over a portion of the sky. I have never seen them coming from the eastward, and only on a few occasions from the southward, they generally proceeding from the west, north-west, or north. If both kinds of light occur at the same time, the second, while passing over the first, dim them. If the second class are watched into daylight they appear as dirty misty clouds that suddenly form and disappear without your being able to say where they came from or where they went to, or as a queer hazy mist over a portion of the sky that suddenly appears and disappears, or as misty rays proceeding from a point in the horizon. Generally when these clouds occur there is a bank of black clouds to the westward.

This season has been very prolific in auroric light, as there have been few nights since the 1st of October last in which they did not appear, sometimes, however, very faint. Generally they were lights of the second class, but on a few occasions there were a few rays of the first associated with them; on wet nights they made the rain-clouds or mist of a reddish purplish colour; tints of which could be seen in some of the excessively dark nights we had in November. On many occasions they were late in the night, being very common and brilliant during the "dark days" of December a few hours before dawn (about five o'clock). I have watched them carefully this season to see if we had a chance of fine weather, but each time we had a fine clear day they appeared also and the weather broke again. Last week I only saw white lights of the first class, very faint on two nights, but the weather has not cleared yet. It has, however, become seasonable, as we have had showers of sleet and snow, while previously it was like spring weather, the trees all budding out, innumerable birds singing morning and evening, and flies and wasps flying about. G. HENRY KINAHAN

Ovoca, January 27

On the Sense of Hearing in Birds

THE sense of hearing is doubtless of much assistance in discovering the food of such birds as the scansores—to wit, woodpeckers, creepers, wrynecks and the like, which feed on insects.

On one occasion, in a Canadian forest, whilst seated close to a rotting pine trunk, I heard distinct scratchings in the interior, as if mice were nibbling the wood, and on splitting open the trunk, numerous large white larvæ of *Hylesinidæ* "woodworms" were found busily employed in making their tunnellings throughout the soft substance of the decayed wood.

Now, while these sounds were audible to human ears, it may be fairly believed that they would have been readily detected by the woodpecker, which may be often observed to halt suddenly on its way up a pine trunk. This *trait* in the mode of climbing is noticeable more or less in all the insectivorous climbers, and appears to me to be caused partly by the bird listening for the sounds produced by insects either in the bark or in the wood. I noticed this particularly in the case of the great black woodpecker (*P. pileatus*) or "log-cock," as it is named in Canada. It would suddenly stop on its way up a tree trunk, and after remaining perfectly motionless for a short time, commence to attack the bark and wood with great vehemence. Every one who has travelled in North American forests will have observed how the excavations made by woodpeckers are often confined to one side of a tree, or to particular situations. And not only on decayed parts, but, as in the case of the extremely tough cedar (*T. occidentalis*), where openings of several inches in circumference have been made through several inches of perfectly fresh wood in order to reach the decaying central layers where wood-eating beetles deposit their eggs and the animal is matured. Admitting that it may have been induced to dig out the insect by tracing the external opening inwards, still in the case of the larvæ the wandering from its birth-place, and the sounds consequent on the tunnelling process, would assuredly be heard by a bird whose ears had been trained to such delicate noises through the necessities of its mode of life. I can therefore well believe that auscultation is of great service to such birds, and also to nocturnal species in discovering their prey. A. LEITH ADAMS

Royal College of Science, Stephen's Green, Dublin

Tapeworm in Rabbits

I WOULD suggest that the tapeworm referred to by Mr. G. J. Romanes is like the Bothriocephalus of man—perhaps a species of the same genus. This is not supposed to have a cystic state, but to be developed from a ciliated embryo taken into the system on raw or badly-cooked vegetables, which have been watered by sewage from cesspools, in which the eggs will remain alive for months.

In the same way the eggs of the rabbit's tape-worm probably remain in the animal's droppings till set free in rain as ciliated embryos. As the rabbit feeds on the vegetation watered by such rain, there is no difficulty in understanding how the embryos would reach his alimentary canal. R. D. TURNER

Meteor of January 7, 10.31 P.M.

THE fine meteor mentioned in NATURE, vol. xv. p. 244, and also seen by Mr. W. H. Wood, p. 295, was observed by many other persons; and as your correspondent asks for another observation of it, the following may be useful:—"J. L. M'C.," writing from Putney Hill, London, says: "As near as I could judge, it appeared between the stars Castor and Pollux (α and β Geminorum), and its course lay almost due north-east, passing over the stars λ and ψ Ursæ Majoris, and disappearing a little beyond the latter star. It was of great brightness, left a tail of fire in its wake about two degrees in length, and was visible some ten seconds." This account, compared with the other two referred to, stands as follows:—

Place.	Meteor. Begun R.A.	Begun Decl.	Ended R.A.	Ended Decl.	Length of path.	Duration in seconds.
	°	°	°	°	°	
London	153	+ 43	200	+ 31	39	Very slow.
W. H. Wood, Birmingham	130	+ 5	182	+ 16	52	5½
J. L. M'C., Putney Hill, London	113	+ 31	170	+ 46	46	10

From these paths the radiant point comes out near γ Eridani, R.A. 58°, Decl. S., 12°, and I can confirm this position from other meteors seen in January, including one as bright as Venus, on the 4th, 8.51 P.M., which exhibited the same slow, halting motion as that noted in regard to the fine one seen on the 7th. I have read other accounts of the latter, but they are mostly vague. At Bermondsey it was seen at 10.30, and described as large and remarkably brilliant, closely resembling in size and colour the meteor which appeared on September 24, 1876. It was of a bluish colour, left a long tail or streak of light in its wake, and its course in the heavens was from south-west to north-east. At 10.37 on the same evening a very large, brilliant meteor was seen at Lower Clapton, and this, no doubt, refers to the same object.

Mr. Barrington (NATURE, vol. xv. p. 275) notes another bright meteor, at 6 P.M., on January 19, but its apparent path shows it to have been different to the one seen by a correspondent at Wolverhampton, at 6.27, January 19, who writes that he witnessed a meteor of "unusual magnitude and brilliancy. It moved almost perpendicularly, in a southerly direction, very slowly, the time occupied in its passage being about seven or eight seconds."

Ashley Down, Bristol W. F. DENNING

THE UNITED STATES GEOGRAPHICAL AND GEOLOGICAL SURVEY OF THE WESTERN TERRITORIES UNDER DR. F. V. HAYDEN

Explorations in 1876.

WE have been furnished with some early notes upon the results of the work of Dr. Hayden's survey during the past year, from which we make the following extracts:—

"For reasons beyond the control of the geologist in charge, the various parties composing the United States Geological and Geographical Survey of the Territories did not commence their field-work until August. Owing to the evidences of hostility among the northern tribes of Indians, it was deemed most prudent to confine the labours of the survey to the completion of the Atlas of Colorado. Therefore the work of the season of 1876 was a continuation of the labours of the three preceding years, westward, finishing the entire mountainous portion of Colorado, with a belt of fifteen miles in width of northern New Mexico, and a belt twenty-five miles in breadth of Eastern Utah. Six sheets of the Physical Atlas are now nearly ready to be issued from the press. Each sheet embraces an area of over 11,500 square miles, or a total of 70,000 square miles. The maps are constructed on a scale of four miles to one inch, with contours of two hundred feet, which will form the basis on which will be represented the geology, mines, grass, and timber lands, and all lands that can be rendered available for agriculture by irrigation. The areas of exploration of the past season are located in the interior of the continent, far remote from settlements, and among the hostile bands of Ute Indians that attacked two of the parties the previous year."

The force was divided by Dr. Hayden into four parties. The first, for primary triangulation, under Mr. A. D. Wilson, with Mr. Holmes as artist and geologist, accomplished the survey of an area of about 1,000 square miles. The second, or Grand River party, under Mr. Garnett as topographer, and Dr. Peale as geologist, surveyed about 3,500 square miles. The third, or White River Division, with Mr. Chittenden as topographer, and Dr. Endlich as geologist, spent forty-eight days in absolute field-work, and reports a surveyed area of 3,800 square miles, in the accomplishment of which 1,000 miles of traverse were made, while forty-one main topographical stations and sixteen auxiliary ones were established. The fourth, or Yampah party, conducted by Mr. Bechler, topographer, assisted by Dr. White, geologist, surveyed about 3,000 square miles. Thus, during the two months of last autumn, these active explorers surveyed about 11,300 square miles of territory (that is more than the whole of the southern or lowland part of Scotland) with sufficient accuracy and detail to permit of the construction of a general map on this scale of four miles to an inch, and with contour lines at successive elevations of 200 feet to mark the main topographical features. Fortunately the geological structure is of extreme simplicity, otherwise such rapid and useful work would be impossible. Dr. Hayden and his associates are doing good service by making known in this way the main features of those vast territories, leaving the details to be worked out at a later time.

Among the most interesting geological results obtained last year are some additional particulars regarding the brackish water-beds lying at the base of the tertiary rocks of these western territories. Three new species of

Unio were found, making six in all, now known to occur in these strata.

"They are all of either distinctively American types or closely related to species now living in American fresh waters. They represent by their affinities the following living species:—*Unio clavus*, Lamarck; *U. securis*, Lea; *U. gibbosus*, Barnes; *U. metaneorus*, Rafinesque; and *U. complanatus*, Solander. They are associated in the same stratum with species of the genera *Corbula*, *Corbicula*, *Neritina*, *Viviparus*, &c., and which stratum alternates with layers containing *Ostrea* and *Anomia*. The close affinity of these fossil *Unios* with species now living in the Mississippi river and its tributaries, seems plainly suggestive of the fact that they represent the ancestry of the living ones. An interesting series of facts has also been collected, showing that some of the so-called American types of *Unio* were introduced in what is now the great Rocky Mountain region as early as the Jurassic period, and that their differentiation had become great and clearly defined as early as late Cretaceous and early Tertiary times. Other observations suggest the probable lines of geographical distribution, during the late geological periods of their evolutional descent, by one or more of which they have probably reached the Mississippi river system, and culminated in the numerous and diverse forms that now exist there.

"The work of the past season shows very clearly the harmonious relations of the various groups of strata over vast areas, that although there may be a thickening or a thinning out of beds at different points, they can all be correlated from the Missouri river to the Sierra Nevada basin. The fact also that there is no physical or palæontological break in these groups over large areas from the Cretaceous to the Middle Tertiary, is fully established. The transition from marine to brackish water forms of life commences at the close of the Cretaceous epoch, and without any line of separation that can yet be detected, continues on upward until only purely fresh-water forms are to be found. Dr. White, an eminent palæontologist and geologist, says that the line must be drawn somewhere between the Cretaceous and Tertiary epochs, but that it will be strictly arbitrary, as there is no well-marked physical break to the summit of the Bridger group." A. G.

ALLOY OF PLATINUM AND IRIDIUM FOR A NEW METRIC STANDARD OF LENGTH

THE Warden of the Standards has, in his valuable annual reports, described the steps which have been taken to secure new International Metric Standards, and Mr. Chisholm has also given abundant information as to the various points of interest connected with their preparation and preservation. The advantage of employing an alloy of platinum and iridium appears to have been so conclusively demonstrated that the French Chamber granted, in November, 1875, 260,000 francs (10,400*l.*) for the expenses of constructing the new International Prototype Standards, and, of this sum, 257,500 francs were required for the cost of an alloy containing 90 per cent. of platinum, and 10 per cent. of iridium, of which they were to be made.[1]

The preparation of a bar for a standard of length has been undertaken for the Association Géodésique Internationale by Messrs. Johnson, Matthey and Co., who presented the results of their labours to the Academie des Sciences on December 4 last.[2] The platinum and iridium used were prepared by the processes of MM. St. Claire Deville and Debray, and they were analysed in their laboratory before fusion. Mr. George Matthey thus describes the method by which this difficult task was accomplished. Five ingots were prepared by melting together in each case 450 ounces of platinum and 55 ounces of iridium. These were then cut in small pieces by the aid of an hydraulic press, and the fragments melted together and kept fluid by a flame of coal gas and oxygen. The ingot obtained was laminated, cut into strips, and again melted into an ingot, which appeared to be very homogeneous and free from roughness or visible flaws. This ingot was forged into a bar 35 cm. long, 7·5 cm. wide, and 2·5 cm. thick. The greater part of this was repeatedly annealed and rolled between polished cylinders of steel until it was 4·10 metres long, 21 mm. wide, and 5 mm. thick, which were very nearly the required dimensions. Then a perfectly rectangular form was imparted to the rule by means of a "drag-bench," and the finishing was effected by a planing machine, as the alloy, owing to its extreme hardness, removed iron from the plates through which it was drawn.

After Mr. Matthey's communication had been read, M. St. Claire Deville gave the result of a careful examination to which he had submitted the bar. He found that the alloy in the form of an ingot has a density 21·508 at 0° C., an oblong mass cut from the bar, was found to be, after annealing, of the density 21·516, which showed that when annealed, at a high temperature, the metal assumes very nearly the density of the fused metal. It was proved by analysis to contain—

	I.		II.
Platinum	89·40	...	89·42
Iridium	10·16	...	10·22
Rhodium	·18	...	·16
Ruthenium	·10	...	·10
Iron	·06	...	·06
	99·90	...	99·96

From which the following figures were deduced:—

	Proportion.	Density at 0 C.	Volume.
Platinum Iridium at 10 per cent.	99·33	21·575	4·603
Iridium in excess	0·23	22·380	0·010
Rhodium	0·18	12·000	0·015
Ruthenium	0·10	12·261	0·008
Iron	0·06	7·700	0·008
	99·90		4·644

Density at 0° C. calculated from analysis No. I. = 21·510
" " " " No. II. = 21·515

which agree perfectly with the results of the analyses, and with regard to them it should be pointed out, that it is very difficult to purify platinum and iridium, and that the smallness of the amounts of rhodium and ruthenium present affords additional evidence of the care with which the refining was performed. It is well known that all substances capable of being tempered, such as glass and steel, change their dimensions in time, others which become crystalline with changes of temperature, as zinc does, are in the same case. The researches of Mr. Wild have shown that hyalite, a variety of opal, appears to be free from this mobility of form, and consequently of density. With facts such as these in view, M. St. Claire Deville proposes to make certain experiments in conjunction with M. Mascart, to determine whether platinum-iridium is subject to a permanent change of volume or not.

The work upon which the accuracy of standards depends is of the highest importance, and Mr. Matthey has well sustained the reputation of this country for technical skill. Metallurgists will appreciate his success, for they can recognise the difficulty he has had to contend with in the fusion and working of such an alloy, but for those who are less familiar with the conditions which had to be met, we would quote the graceful words of MM. Dumas and Deville. The former observed: "Il a exécuté ce travail avec un succès complet sous le double rapport de la composition exacte de l'alliage et de la forme de la règle .... l'intérêt actuel est évident, et la production enrichit l'outillage scientifique d'un alliage doué de propriétés précieuses." M. Deville said: "Qu'il me soit permis, en terminant, de remercier le métallurgiste habile, le savant distingué, M. G. Matthey, qui a accompli son œuvre avec un talent et un désintéressement qui ne seront pas perdus pour la science."

W. CHANDLER ROBERTS

[1] Tenth Annual Report of the Warden of the Standards, 1876, p. xxxiv.
[2] *Comptes Rendus*, No. 23, 1876, p. 1,090.

THE UPPER COLORADO[1]

AMONG the most eminent services rendered by American geologists to the cause of science, there can be little hesitation in placing the labours of Lieut. Ives and Dr. Newberry as given to the world in their well-known Report on the Colorado country of the West. By pen and pencil they brought vividly before the eye and the imagination the structure and scenery of a region so singular and so stupendous in its memorials of slow prolonged subaerial erosion as not only to throw every other known district of the kind far into the shade, but to furnish proofs of the potency of river-excavation, which even the keenest advocates for the power of rain and rivers at first hesitated to believe. Since that Report appeared, however, additional and confirmatory illustrations of the same marvellous scenery have been published by other observers, notably by Hayden and Powell. The gorges of the Colorado, with walls sometimes more than a mile high and running for nearly five hundred miles across the tableland, are now more or less familiar, from descriptions and sketches, to the geologists of all countries. They are admitted, too, to be due, as Dr. Newberry first contended, to the gradual erosive action of the rivers by which they are traversed. The whole of this Colorado basin or plateau is justly regarded as the most magnificent example on the face of the globe of how much the land may have its features altered by the agency of running water.

In the present Report Dr. Newberry gives the results of a second exploration to the Colorado, but to a more northern or higher tract than that embraced in his previous journey. The Expedition took place as far back as 1859, and this Report was written and sent to the authorities by the beginning of May, 1860. At that time, however, the Civil War was impending, by which not only this publication but many others of importance were arrested. The recent surveys of the Department of the Interior and the Bureau of Engineers having called renewed attention to the Colorado region, Col. Macomb and Dr. Newberry have succeeded, at last, in inducing the authorities to print and circulate their account of the observations made by them seventeen years ago. It is a welcome contribution to the literature of the subject. Dr. Newberry, by his summary and his narrative of detail, combined with his clever lithographic sketches, presents us with so vivid a picture of the landscapes through which he has wandered and of the geological structure which has given them their character, that nothing further can be desired save a personal visit to the marvels themselves under his experienced guidance. Four of the most characteristic views are here reproduced as woodcuts.

Westwards from the Rocky Mountain ranges to the head of the Gulf of California the basin of the Colorado stretches as a vast plateau, broken by the transverse gorge of the Great Cañon, at the bottom of which, from 3,000 to 6,000 feet below the level of the plain, the river wanders to and fro for nearly 500 miles. The plateau is further marked by a succession of terraces ending in steep walls sometimes 1,000 feet or more in height, and by occasional isolated mountain areas which rise above the general level like islands from the sea. These various inequalities, however, when seen from any of the eminences bordering the plateau are almost lost in the vast sweep of the level plain. On all sides the table-land is surrounded with mountain-ranges which seem on the whole to have a meridional direction, so that the tableland itself would appear to be a tract which has somehow escaped plication during the movements by which the encircling ridges were formed. The isolated mountains on this plain, however, indicate the same north and south trend, are composed like these bounding ridges, and may be referred to the same series and to a similar mode of origin.

In that upper part of the Colorado plateau now described by Dr. Newberry we recognise the same geological formations as well as the same striking features of colour which have given its name to the chief river. The oldest rocks belong to the Carboniferous system. Thence up to strata believed to represent the earlier Tertiary series of Europe there is a continuous conformable development of stratified deposits. These strata spread out in horizontal sheets over the plateau. On the eastern and western margins they have been heaved up along the flanks of the mountain ridges, and here and there, where an isolated axis of elevation or a dislocation occurs on the plain, they have likewise been upturned. But for the most part they retain their horizontality, so that the lower formations are not seen, except where they have been cut into at the bottoms of the cañons. The Carboniferous limestones contain such characteristic brachiopods as *Productus semireticulatus*, *P. scabriculus*, *P. punctatus*, *Spirifer*, and *Athyris*. The earliest records of that region, therefore, are those of a sea-floor, which must have stretched eastwards across what is now the range of the Rocky Mountains towards the land which then lay over the site of the Eastern States. The thickening out of the marine limestones towards the west establishes this point in the ancient physical geography of the American continent. Above the Carboniferous limestones and shales lie a conformable series of bright red, green, and yellow sandstones, shales, and marls, which are regarded by Dr. Newberry as Triassic, and perhaps partly Jurassic, and which pass conformably upward into massive yellow and grey sandstones and green shales, which are placed on the horizon of the Lower Cretaceous rocks. These latter strata, containing many cycads and ferns, with other traces of terrestrial conditions, form the surface over an enormous area of the table-land. As they approach the broader valleys they end off in a steep cliff or bluff like a sea-wall, often cut along the edges into numerous detached tables, pinnacles, and quaintly-shaped outliers. The red strata underneath form the platform out of which the deep gorges have been eroded and their bright colours running in parallel stripes along the walls of the cañons and the faces of the isolated fragments and pillars give an extraordinary character to the fantastic forms into which the rocks have been worn.

The want of any evidence of disturbance from palæozoic up into older Tertiary time is dwelt upon by Dr. Newberry in this Report as showing the simplicity of the structure of this part of the continent. The facts which he brings forward help to make our ideas still clearer of the stages by which the present physiography of America has been reached. He demonstrates the truth of his previous conclusion that the region of the Colorado is one of vast erosion, and he gives some interesting indications of the extent of this denudation. He shows that the great plain with its surface of firm Lower Cretaceous sandstone was once covered by a continuous sheet of soft Middle and Upper Cretaceous shales, of which scattered mounds and millions of loose fossils are strewn over the plain, and which rise along its margin into an upper plateau overlooking the great tableland and presenting a steep escarpment towards it. These overlying strata are at least 2,000 feet thick. There cannot be any doubt, therefore, that previous to the erosion of the profound gorges the tableland was buried under 2,000 feet of soft strata, all of which have been removed except these fragmentary relics. Dr. Newberry satisfactorily disproves the notion that this denudation could have been effected by any violent current like those waves of translation which used to be called in to account for the existence and distribution of the glacial drift and erratic blocks. No one can read his

[1] Geological Report, by J. S. Newberry, M.D., of the United States Exploring Expedition under Captain J. N. Macomb, from Santa Fé, New Mexico, to the Junction of the Grand and Green Rivers of the Great Colorado of the West. (Washington, 1876.)

pages without a conviction that he correctly regards the whole erosion of the Colorado region as one vast continuous process in which air, rain, frosts, and rivers have been the main agents.

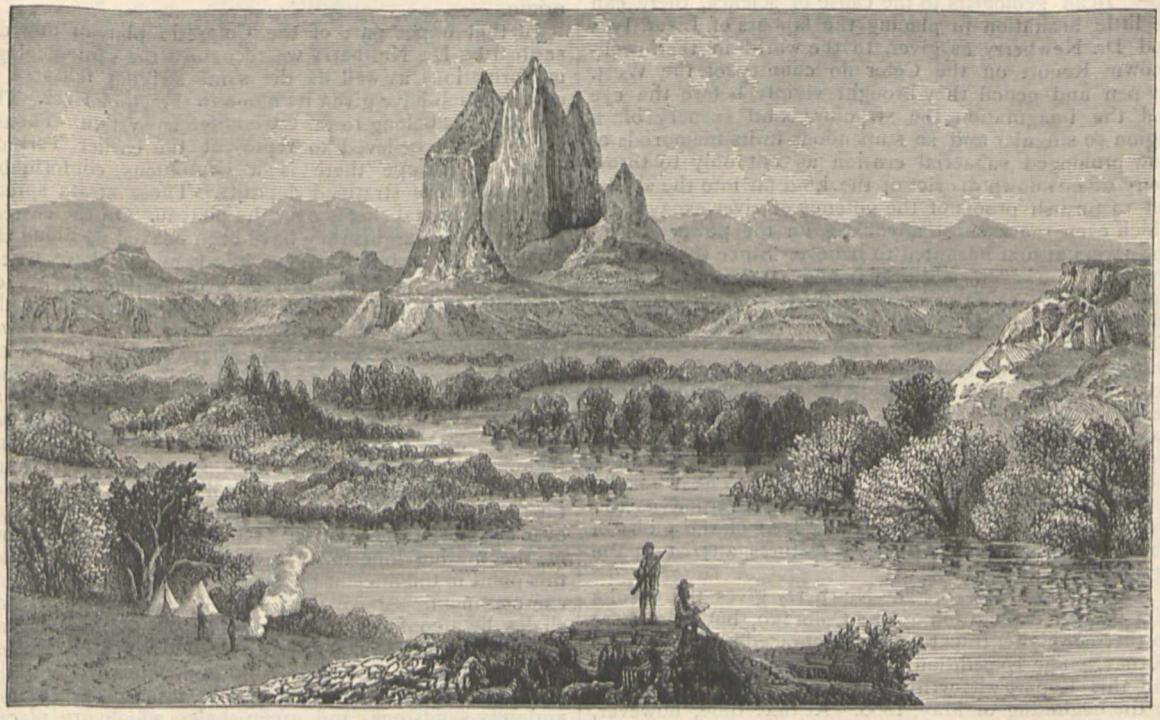


FIG. 1.—The Needles, looking South-westerly.

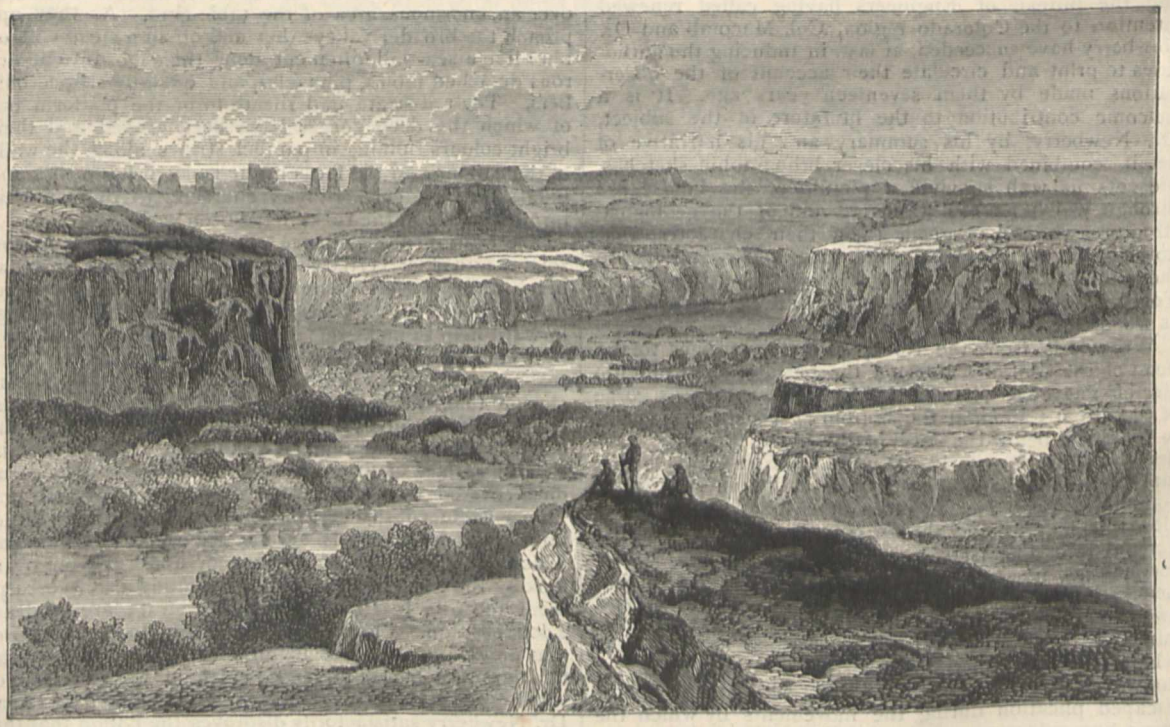


FIG. 2.—Lower San Juan, looking West.

The observations contained in this Report upon the structure of the isolated ridges which now and then disturb the horizontality of the stratified formations of the great plain are of considerable interest and importance. They

show that the elevation of these ridges did not take place until after the deposition of the older Tertiary rocks, and that this elevation was not merely due to the protrusion of hypogene masses, but was part of a general and prolonged

FIG. 3.—Head of Labyrinth Creek, looking South-easterly.

FIG. 4.—Head of Cañon, Colorado. Erosion of Triassic Series.

movement of plication by which the present axis of the North American continent was determined. The whole of the sedimentary formations of the plain are found bent up against the granitic nucleus, which, like a wedge, has

been driven through them. No proof of any such movement or of any volcanic action older in date than the Eocene, or Upper Cretaceous rocks, was obtained in this Expedition. So that we have here, apparently, an area where any subterranean movements which occurred never disturbed the conformable succession of deposits during that vast section of geological time from the Carboniferous (or even from the Silurian) up to the Eocene period. Whether the traces of terrestrial surfaces indicated by the plants and lignite beds of the Lower Cretaceous series, occurring as they do with marine strata below and above them, are to be regarded as marking oscillations of the crust, or as due merely to the gradual up-filling of the old sea-basin and its conversion into lagoons and terrestrial surfaces which were subsequently gently submerged again beneath the Middle and Upper Cretaceous seas, may be a question for discussion. It would seem that coincident with or subsequent to the pre-Miocene plication and upheaval, volcanic action began in the Western States. Dr. Newberry gives a drawing and a description of a singular basaltic rock called the Needles (Fig. 1) rising to a height of 1,700 feet above the Cretaceous floor of one of the tributary valleys of the San Juan, and regards this mass as having been intruded among the strata and as now left visible owing to its superior hardness, while the surrounding and overlying softer rocks have been washed away. But in his former Report in conjunction with Lieut. Ives, he showed the existence of a group of large extinct volcanoes in the San Francisco mountain group in Arizona, lying on the south side of the Colorado basin. The lava-streams are yet so fresh there that he supposes that the last eruption can hardly have taken place more than a comparatively few years ago. Considerably further to the east in New Mexico, San Mateo rises as another important extinct volcanic cone 11,000 or 12,000 feet high, whose most recent lavas are so fresh that "it is difficult to believe that they have been exposed to the action of the atmosphere even for so much as a hundred years." Dr. Newberry remarks that similar but smaller volcanic vents equally recent in appearance, but equally inactive now, are scattered over the entire area of the central tablelands from Mexico far up into the British possessions.

The author, who is an accomplished palæontologist as well as an active and gifted geologist, has added a valuable Appendix, in which he gives descriptions of the Carboniferous and Triassic fossils obtained by him in the course of the Expedition, and to which Mr. F. B. Meek[1] contributes an account of the Cretaceous fossils collected. It should be added, that besides the lithographic sketches the Report is enriched by some excellent plates of fossils.

ARCHIBALD GEIKIE

DEEP SEA MUDS[2]

II.

Peroxide of Manganese.

PEROXIDE of manganese occurs widely in ocean deposits, either as nodules, incrustations, or as depositions on the bottom itself. It has been found most frequently in the nodular form in the deep sea clays far from land. It also occurs in the organic oozes, when these contain much volcanic *débris*, or are near volcanic centres.

In shallow water, near some volcanic islands, it covers shells and pieces of coral or pumice with a light brown incrustation. It has been met with very sparingly, if at all, in shore deposits removed from volcanic centres.

In my preliminary report above referred to, I stated that further investigation might show that manganese nodules and depositions abound in these regions where we have much of the *débris* of augitic or heavy lavas.

A re examination of specimens since our return confirms this view. Wherever we have pumice containing much magnetite, olivine, augite, or hornblende, and these apparently undergoing decomposition and alteration, or where we have evidence of great showers of volcanic ash, there we find the manganese in greatest abundance. This correspondence between the distribution of the manganese and volcanic *débris* appears to me very significant of the origin of the former. I regard the manganese, as we find it, as one of the secondary products arising from the decomposition of volcanic minerals.

Manganese is as frequent as iron in lavas, being usually associated with it though in very much smaller amount. In magnetite and in some varieties of augite and hornblende the protoxide of iron is at times partially replaced by that of manganese.

In the manganese of these minerals and in the carbonic acid and oxygen of ocean waters we have the requisite conditions for the decomposition of the minerals, the solution of the manganese, and its subsequent deposition as a peroxide.

The carbonic acid converts the silicates of the protoxides of manganese, and the protoxides of manganese into carbonate of manganese, and thus prepares the way for oxidation by the oxygen of the water.

It is probable that the action of the carbonic acid is not apparent, and that the manganese is at once deposited as a high oxide if not as the peroxide. This theory is essentially the same as that which Bischof gives for manganese ores generally. I have laid a series of these manganese depositions on the table. An inspection of these and their localities will show that in the clays and oozes the depositions are nodular in form. If a section be made of one of these, a number of concentric layers will be observed arranged around a central nucleus—the same as in a urinary calculus. When the peroxide of manganese is removed by strong hydrochloric acid, there remains a clayey skeleton which still more strongly resembles a urinary calculus.

This skeleton contains crystals of olivine, quartz, augite, magnetite, or any other materials which were contained in the clay from which the nodule was taken. In the process of its deposition around a nucleus, the peroxide of manganese has inclosed and incorporated in the nodule the clay and crystals and other materials in which the nucleus was imbedded. The clayey skeleton thus varies with the clay or ooze in which it was formed. Those from a fine clay usually adhere well together; those from a globigerina ooze have an areolar appearance; those from a clay with many fine sandy particles usually fall to pieces. Mr. Buchanan informs me that the purest portions of these nodules, that is those portions made up of closely-packed concentric layers, contain from 30 to 34 per cent. of the peroxide.

Taking the nodule as a whole, it will of course contain very much less than this. The nucleus varies in each nodule, and that part of a nodule which is made up of concentric layers will vary with each locality and with the depth from which it comes. We may expect, therefore, that analysis will show considerable variations in the amount of alumina, silica, and metals, lime, &c., in the nodules from different stations. At some places in the Pacific the nodules show periods of deposition very distinctly. We have first a very compact nodule which may have a shark's tooth for a nucleus, and which appears to have been formed slowly. Then there would seem to have been a shower of ashes. After a time manganese was again deposited, inclosing in the nodule a layer of these ashes. The most frequent nucleus in the nodules is a piece of pumice or other volcanic fragment.

In deep sea clays, far from land, sharks' teeth, ear-bones of whales, and fragments of other bones are very often the nucleus around which the manganese is deposited. In one instance a piece of siliceous sponge forms the nucleus. In a globigerina ooze a portion of the deposit has apparently formed the nucleus. In these we have perfect casts of the foraminifera, but all the carbonate of lime has been removed. The volcanic fragments which have formed the nuclei of nodules appear frequently to have undergone peculiar alterations. For instance, obsidian is usually surrounded by beautiful agate bands.

When we found the bottom composed almost entirely of volcanic ashes, or so hard from other reasons that the sounding tube did not penetrate it, the manganese was deposited in layers over

[1] Since this article was written, the announcement of Mr. Meek's death has reached this country. A more disastrous blow could not have been inflicted upon the progress of palæontology in the United States. It is much to be desired that amid the universal regret with which the death of this able palæontologist is received, some record shall be published of the services he has done. His numerous papers are scattered through so many publications (for he seems to have been ever at the call of any one who needed his assistance), that probably a comparatively small number even of palæontologists are aware of them all.

[2] "On the Distribution of Volcanic Débris over the Floor of the Ocean; its Character, Source, and some of the Products of its Disintegration and Decomposition," by Mr. John Murray. Read at the Royal Society, Edinburgh. Continued from p. 321.

the bottom itself. Large pieces of this nature were taken several times.

The escape of carbonic acid through the floor of the ocean near volcanic islands may in these regions greatly accelerate the processes which end in the deposition of the peroxide of manganese, and account for the great abundance of it in some such localities where we found it.

Native Iron and Cosmic Dust.

While examining the deposits during the cruise I frequently observed among the magnetic particles from our deep sea clays small round black-coloured particles which were attracted by the magnet, and I found it difficult to account for the origin of these.

On our return home I entered into a more careful examination of the magnetic particles. By means of a magnet carefully covered with paper I extracted these particles from the deposits, from the pumice-stones, and from the manganese nodules of many regions. The great majority of these magnetic particles are magnetic iron ore and titaniferous iron, either in the form of crystals or as fine dust. In the clays and in the manganese nodules from stations far from land and in deep water there were again noticed many small round spheres among the magnetic particles.

On mentioning this to Prof. Geikie he suggested that I should try the method employed by Prof. Andrews, of Belfast, for detecting minute particles of native iron.

This process consists in moistening the magnetic particles, which have been extracted by means of the magnet, with an acid solution of sulphate of copper, when copper is at once deposited on any native particles which may be present. In this way I have detected native iron in many of our deposits, in the powdered portions of manganese nodules, and in pumice-stones.

Prof. Andrews tells me that there can be little doubt that the particles on which copper is deposited are native iron, as he has found that it is not deposited on nickel, and the chances of cobalt being present are very slight. Prof. Andrews warned me on the extreme precautions necessary in conducting these observations, that no iron from a hammer or other instrument should get at the specimen under observation.

It is true that all specimens of our deposits have been obtained by means of dredges and iron gear, and some of these particles may be from this source.

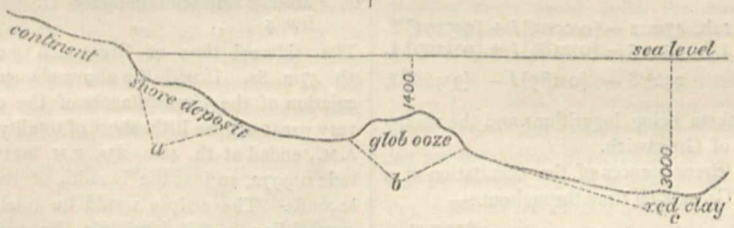
Many of the particles must have another origin. I have taken two of our manganese nodules, and washing them carefully, taking care to let no iron instrument come near them, have broken them by rapping them together. Then taking only the interior parts of these nodules I have pulverised them in a porcelain mortar. The magnetic particles were afterwards extracted by a magnet covered with paper. Now, placing these particles on a glass slide under the microscope, and adding the sulphate of copper solution, there was in a few moments a deposit of copper on several small perfect spherules, varying in size from the $\frac{1}{1000}$ to the $\frac{1}{300}$ of an inch in diameter. I have placed some of these spherules under the microscope and now show them to the Society. It will be noticed that on one the copper is not deposited all over the sphere, but in ramified spider-like lines. On the cut surface of a meteorite, from Prof. Sir Wyville Thomson's collection, which I also exhibit, the copper is precipitated in precisely the same manner as on the little sphere on the manganese nodule. Besides the spherules on which the copper is deposited, there are others generally of a larger size and dark colour. These are, so far as microscopic examination shows, quite like the particles on the mammilated outer surface of this Cape meteorite, also from Sir Wyville's collection.

These spherules have hitherto only been noticed in those deposits in deep water far from land, and where for many reasons we believe the rate of formation of deposits to be very slow.

They occur also only in those manganese nodules which come from the same deep sea clays or deposits far from land.

The particles of native iron found in pumice-stones are not numerous, and never take the form of spherules so far as observed. Some of these particles of native iron may then come from the dredge. Other particles come from the pumice and the volcanic materials. Prof. Andrews long since showed that minute particles of native iron existed in basalt and other rocks. And lastly, the spherules of which I have been speaking, appear to have a cosmic origin.

The reason for these spherules occurring only in deposits far from land and in deep water, may be more apparent by reference to the annexed diagram, which might represent a section from the west coast of South America out into the Pacific 500 miles. Along the shores of the continent, as at *a*, we have an accumulation of river and coast detritus. At *b* in depths from 1,400 to 2,200 fathoms we have a globigerina ooze mostly made up of surface shells. At *c*, in a depth of 2,300 to 3,000 fathoms, all the surface shells are removed from the bottom. No coast detritus reaches this area, and we find in the deposit pumice stones, some volcanic ashes, manganese nodules, sharks' teeth, and ear-bones of whales. It is only in areas like this that we find sharks' teeth and ear-bones of cetaceans in any numbers. Some of them from the same haul are deeply surrounded with manganese deposit, and contain little animal matter, while others have no deposit on them, and seem quite recent. These, and other facts which might be mentioned, all argue for an exceedingly slow rate of deposition. Now it is in these same areas that the spherules of native iron and other magnetic spherules are found, both in the deposits and in the manganese nodules from them.



Finding them in this situation favours the idea that they are of cosmic origin, for in such places they are least likely to be covered up or washed away. It is certainly difficult to understand why the spherules on which the copper is precipated have not become oxidised. If nickel be present in them, this may retard oxidation to some extent.

The manganese depositions in our ocean deposits are very different in structure and composition from any of the ores of manganese I have had an opportunity of examining, and the deposits of the deep sea far from land have not, so far as I know, any equivalents in the geological series of rocks.

All the subjects treated of in this paper are still under investigation, and at some future time I hope to present a much more detailed account.

These observations seem to me to give ground for the following conclusions :—

First.—That volcanic *débris*, either in the form of pumice stones, ashes, or ejected fragments, are universally distributed in ocean deposits.

Second.—That pumice stones are continually being carried into the sea by rivers and rains, and are constantly floating on the surface of the ocean far from land.

Third.—That the clayey matter in deposits far from land is principally derived from the decomposition of the feldspar in fragmental volcanic rocks, though in the trade wind region of the North Atlantic the dust of the Sahara contributes much material for clay.

Fourth.—That the red earth of Bermuda, Bahamas, Jamaica, and other limestone countries, is most probably originally derived from the decomposition of pumice stone, while these limestones were in the process of formation.

Fifth.—That the peroxide of manganese is probably a secondary product of the decomposition of the volcanic rocks and minerals present in the areas where the nodules of manganese are found.

Sixth.—That there are many minute particles of native iron in deposits far from land ; that some of these particles are little spherules ; that these last, as well as some other spherules which are magnetic, have probably a cosmic origin.

Seventh.—That the peroxide of manganese depositions in the

deep sea are different in structure and composition from known ores of manganese.

Eighth.—That we do not appear to have equivalents of the rocks now forming in the deep sea far from land, in the geological series.

In conclusion, I have to acknowledge much assistance in these investigations from all my colleagues, especially my indebtedness to Sir Wyville Thomson and Mr. Buchanan.

Since my return I have received many hints from Profs. Tait, Geikie, Turner, Dr. Purves, Mr. Morrison, and other gentlemen.

In much of the mechanical work which an examination of these deposits has entailed, I have, both during the cruise and since my return, had the assistance of Frederick Pearcey.

OUR ASTRONOMICAL COLUMN

NEW COMET.—M. Stephan, Director of the Observatory at Marseilles, announces the discovery of a new comet by M. Borrelly on the morning of the 9th inst. It is described as bright, round, with a well-defined nucleus, and 3½ minutes in diameter. The first complete observation gave for its position—

February 8 at 16h. 57m. 58s. M.T. at Marseilles.

Apparent Right Ascension ... ... 17h. 13m. 22·7s.
,, North Polar distance ... ... 91° 28′ 20″
Diurnal motion in R.A. + 1m. 44s. ; in N.P.D. − 3° 7′.

M. Borrelly was also the discoverer of the last unpredicted comet, on December 6, 1874, in which year six comets were observed ; in 1875 only two were observed, both known comets of short period ; in 1876 none.

THE OCCULTATION OF REGULUS ON FEBRUARY 26.—The occultation of a star of the first, or between the first and second magnitudes, is a sufficiently uncommon phenomenon to attract attention. Regulus will be occulted on the 26th instant while the moon is at a considerable altitude, and to facilitate the calculation of the times of immersion and emersion at any place in this country we will apply the very convenient method given by the late Prof. Littrow for distributing such predictions over a limited area.

Putting the latitude of the place = 50° + *l*, and expressing *l* in degrees, and the longitude from Greenwich = L, and expressing L in minutes of time, + if east, − if west, and founding the equations upon direct computations for Greenwich, Edinburgh, and Dublin, we find with the *Nautical Almanac* elements,

Time of Immersion = 12h. 47m·2 − [0·0095]*l* + [9·5191] L
,, Emersion = 13h. 53m·5 − [0·2188]*l* + [9·3209] L
Angle at Emersion from N. Point = 232°·8 − [0·185]*l* − [9·468] L

The quantities within brackets being logarithms and the resulting times for the meridian of Greenwich.

The following are the circumstances of the occultation at a few of our observatories; Greenwich time throughout :—

	Immersion.	Emersion.	Ang'e at Emersion.
	h. m.	h. m.	°
Cambridge	12 45·1	13 49·9	229
Dublin	12 35·4	13 42·5	235
Edinburgh	12 36·9	13 40·9	227
Greenwich	12 45·7	13 51·0	231
Liverpool	12 39·7	13 45·2	231
Oxford	12 43·7	13 49·5	232

No other occultation of so bright a star, visible in this country, will take place until July 28, 1879, when Antares will be occulted.

Amongst the Chinese observations collected by the Jesuit missionary, Gaubil, are a number of occultations of Regulus, the earliest of which is dated March 16, A.D. 501. While referring to this star, we may mention a remarkable approximation of several planets near it, which is also recorded in the Chinese annals, and which, so far as we know, has never been examined. As interpreted by Gaubil, the observation runs thus :—

In B.C. 27, second year Ho-ping, in the tenth moon, between the 20th and last day of the moon, Saturn distant from Regulus 1° (Chinese measure), Jupiter to the north-west 1°, Mars to north-west 2°.

The Chinese commenced their year at the new moon immediately preceding the sun's entry into the sign Pisces, and their months were lunar. Accordingly in B.C. 27 the first moon commenced soon after midnight on February 10, Greenwich time, and the tenth moon on the evening of November 2 ; the time indicated by the Chinese record is therefore probably between November 23 and December 2. Perhaps some one may have the curiosity to examine this reported conjunction of Mars, Jupiter, Saturn, and Regulus. We can state positively that an occultation recorded about forty years earlier, observed under the same dynasty, Han, and at the same station, that of the Chinese court at Si-gnan-fou, in the province of Chen-sy, actually occurred, according to our latest tables, and at the hour recorded in the Chinese annals.

THE SOLAR ECLIPSE OF 1567, APRIL 9.—Prof. Grant, in his valuable "History of Physical Astronomy," remarks that "the earliest eclipse which was unequivocally asserted to have been annular was one which occurred in the year 1567." It was observed at Rome by Clavius, of Calendar celebrity, who has recorded that when the obscuration was greatest there still remained round the moon's limb a very narrow ring of the solar light. Kepler ("Ad Vitellionem") found from his tables the sun would have entirely covered the moon, and hence considered that the luminous ring, mentioned by Clavius, was in reality the *corona*, visible during total eclipses of the sun.

The elements of the eclipse of 1567 obtained upon a similar system of calculation to that applied to other modern solar eclipses in this column are as follow :—

Conjunction in R.A. 1567, April 8d. at 23h. 17m. 10s. G.M.T.

	° ′ ″
R.A.	26 30 57
Moon's hourly motion in R.A. ...	33 8
Sun's ,, ,, ...	2 19
Moon's declination	11 27 45 N.
Sun's ,, ...	10 58 57 N.
Moon's hourly motion in decl. ...	9 6 N.
Sun's ,, ,, ,, ...	0 52 N.
Moon's horizontal parallax	57 36
Sun's ,, ,, ...	0 9
Moon's true semi-diameter	15 54·0
Sun's ,, ,, ...	15 41·7

The sidereal time at Greenwich mean noon, April 9, was 1h. 47m. 8s. If with the above elements we make a direct calculation of the circumstances of the eclipse at Rome we find a very great eclipse little short of totality ; began at 10h. 41m. 0s A.M., ended at 1h. 42m. 23s. P.M. mean times at Rome, magnitude 0·9972, so that the breadth of the crescent was about 2½ seconds. The eclipse would be total for a few seconds on the central line in this longitude, the augmented semi-diameter of the moon exceeding the sun's semi-diameter only 1″·5 ; but our result as it stands may very well explain the words of Clavius, the extremely narrow crescent of the solar disc still remaining, added to the probable visibility of the brighter part of the *corona*, giving to the naked eye the appearance of a narrow uniform ring of light.

NEW MINOR PLANET.—No. 172 of the group of small planets was detected by M. Borrelly at Marseilles on the 5th inst. ; at 12h. 8m. its R.A. was 10h. 35m. 36s., N.P.D. 80° 30′·9, twelfth magnitude. On the following night at 9h. 58m. its R.A. was 10h. 34m. 46s., N.P.D. 80° 29′·3.

METEOROLOGICAL NOTES

METEOROLOGY OF THE LIBYAN DESERT.—A second volume of Gerhard Rohlfs' great expedition into the Libyan desert has been recently published at Cassel, under the editorship of Dr.

W. Jordan of Karlsruhe, giving the detailed results of the researches of the expedition into the physical geography and meteorology of this region during the winter of 1873–74. Though the observations extended only over a comparatively brief period, yet from their evidently high quality, the ability with which they have been discussed, and the physical characteristics of the region, the results thereby obtained form an exceedingly valuable contribution to meteorology. The results of the two-hourly observations show, as regards the daily maxima and minima of atmospheric pressure that the forenoon maximum and afternoon minimum are very greatly in excess of the others, and that the difference between them indicates an amplitude of range in accordance with that given for this region in Buchan's recently published charts of diurnal barometric range. The temperature has a daily range of 24°·5, the maximum occurring about 3 P.M., and the minimum a little before 6 A.M. The lowest observed temperature was 23° in the earlier part of February. The minimum of vapour tension occurs about 6 A.M., and the maximum about 11 A.M. While the mean relative humidity at Cairo in winter is 65, it is only 51 in the desert, falling to 35, the minimum at 2 P.M., the dryness of the climate being thus very great. A humidity of only 17 was observed at Sandheim on February 12, at 2 P.M. Rain fell from February 1 to 4, thunder was heard on the second, and during next night 0·48 inch of rain fell, soaking the sand of the desert to a depth of about five inches—an amount of rain of rare occurrence in the district. The prevailing winds are north-westerly, those having the highest percentages being W. 16, N.W. 34, and N. 27, or 77 per cent. Warm springs occur in several of the oases, the highest observed being at Dachel, the temperature of which ranged from 92°·3 to 96°·8, or about 15° above the annual mean temperature of the locality. The magnetic declination was observed on January 1, at ten places variously situated between 25° 11′, and 29° 12′ lat. N., and 25° 31′ and 32° 34′ long. E. of Greenwich, the results of which, when compared with the observations of declination made in 1819-20 by Cailliaud indicates an annual variation of 6′·4, being closely approximate to that of Central Europe.

Height of the Seine at Paris during 1876.—In the *Bulletin International* of the Paris Observatory for January 13, the height of the Seine is given for each day of 1876, as observed at Pont de la Tournelle and Pont Royal. The zero of the scale at Pont de la Tournelle is the lowest point to which the river fell during the great drought of 1719. The highest flood hitherto recorded measured 27 feet in 1658, and the greatest dryness 3·28 feet below the zero of the scale on September 29, 1865. During 1876 the greatest flood was 21 feet on January 17, the greatest dryness 0·89 foot, and the mean for the year 3·15 feet, being 0·82 foot below the mean calculated by Delalande.

Oscillations of Tides.—The meteorological *Bulletin* of the Brussels Observatory for January 26 calls the attention of meteorologists and physicists to a remarkable perturbation in the state of the sea, shown by the *marégraphe* of Ostende. "The low-tide level on January 25," the *Bulletin* says, "was by thirty-five centimetres lower than it should have been, and the high-tide level in the evening was lower by sixty centimetres, as if the tide were stopped in the last part of its ascending motion. These depressions of the sea-level took place under quite the same circumstances of wind at Ostend, as those which were observed during an elevation of the level, on January 2. The local direction of the wind, in the report, cannot be the cause of these oscillations, and the true cause remains thus unknown, and well deserving the full attention of meteorologists and physicists."

Hurricane of January 31, in Belgium and Holland.—The hurricane which, accompanied by an unusally high tide, visited the shores of the North Sea during the night of January 30–31, is reported to have done very great damage. The height reached by the tide at Ostend was 7·5 metres above the mean level of the sea, and the height of the waves during the hurricane was about 12 metres (40 feet), the mareograph showing fluctuations from 13·5 to 1·5 metres above zero. The tide thus exceeded by about 4 feet the highest tides remembered at Ostend. The embankment of the town was destroyed for a length of more than 700 feet, and stones 14 feet long were thrown by the waves to distances of about 40 feet. Large parts of the town were inundated. At Antwerp the tide which swept along the Scheldt was higher by 1 foot than the highest tides remembered. The shores of the river were therefore inundated, as well as some of the polders, which appear now as immense lakes. The streets of Antwerp were covered with water 1 metre deep; Mechlin, Termonde, and many other places, were also flooded. In Holland the ravages were not less. Rotterdam was inundated, the Maas reaching a level only 6 centimetres lower than that reached in 1825. Various other places in Holland suffered. Numerous accounts received at the Brussels Observatory from various points of the kingdom will enable the path of the hurricane to be traced with great accuracy. It is worthy of notice that it took one hour and a half to go from Ostend to Brussels.

Weather Notes.—Letters received from the United States on Saturday last state that the weather on the Atlantic seaboard has been intensely cold; temperatures from −35° to −40° have been recorded. At Baltimore, on the 26th ult., the temperature was the lowest known for many years, and the ice extended fully sixty miles down Chesapeake Bay, effectually blocking the harbour. Several steamers were compelled to put back, being unable to force their way through the ice-fields. Seventy vessels were locked in the ice twelve miles down the bay and the crews were in great distress. Very heavy snow-storms are reported from the west of the State of New York, by which railway travelling was all but stopped. Australian letters report exceedingly intense heat in Victoria during the month of December, the temperature in the shade rising on the 15th to 110°·7 at the Melbourne Observatory, and at some places in the interior, 116°·0 was recorded.

International Weather Maps.—We have the greatest pleasure in noting that the system of simultaneous observations of atmospheric changes for the construction of the valuable weather maps issued under the direction of Gen. Myer, of Washington, U.S., which is already carried practically around the northern hemisphere on land, has recently received a large and important expansion. A general order was issued by the Navy Department, on December 25, to the commandants of naval stations and commanding officers of vessels of war, directing meteorological observations to be taken, recorded, and forwarded to the Bureau of Navigation, a particular officer being designated as responsible for the duty. The observations are to be of such a character as to be suitable for the preparation of synoptic charts, and to embrace, whenever practicable, at least atmospheric pressure, temperature, wind, rain, wet-bulb thermometer, sea-swell, and weather daily, on board every vessel in commission, and at every naval station of the United States at 7.35 A.M. Washington mean time (0.43 P.M. Greenwich mean time). The Secretary of the Navy enjoins the greatest care and promptitude in the taking and recording of these observations, which thus form part of the system of international meteorological observations taken simultaneously, upon which the United States have entered. We very earnestly hope that the navies and the mercantile vessels of all civilised countries will soon join in carrying out this magnificent scheme of observations originated by the Americans in 1873, and since then further developed and carried on by them with the highest ability and success.

NOTES

ACCORDING to arrangements made since the death of Prof. J. C. Poggendorff, the *Annalen der Physik und Chemie* will in future be edited by Prof. Dr. G. Wiedemann, of Leipzig, assisted by Prof. Helmholtz and the Physical Society of Berlin. Prof. Wiedemann possesses admirable qualities for the new position, and under his supervision this well-known scientific journal will at least lose none of its former valuable features. The first number of the *Beiblätter*, the newly-founded adjunct to the *Annalen*, has already been issued. It will not only offer a review of contemporary physical research, but will seek to replace the supplementary volumes of the *Annalen*.

THE Council of the Royal Society of Edinburgh has awarded the Macdougall-Brisbane Gold Medal to Mr. Buchan for his paper on the diurnal oscillation of the barometer, as forming one of an important series of contributions by him to the advancement of meteorological science.

THE great Von Baer medal, worth over 1,000 roubles, and bestowed but once in three years, has been given by the St. Petersburg Academy of Sciences, to Dr. A. Götte, Professor of Zoology at Strasburg, in recognition of his remarkable work "Die Entwickelungsgeschichte der Unke."

A MEDAL to commemorate the part taken by the Institute of France in the observation of the transit of Venus has been struck at the national mint. It bears the representation of a female passing before the car of Apollo, with the motto in Latin, "Quo distent spatio, sidera juncta docent." Each member of the Institute has received a silver medal, as well as the heads of the mission; the assistants received a bronze one. A medal has been cast in gold and presented to M. Dumas, the President of the Transit Commission. The expenses were defrayed by subscription among the members of the Institute.

DR. STRAUDBERG, the president of the Swedish Academy of Sciences, died suddenly in Stockholm on February 5.

THE Norwegian Government proposes to send out a vessel during this year for the purpose of deep-sea exploration in the Atlantic. A credit of 103,000 kronen has been sought from the national Parliament to cover the expense of the expedition.

BARON BARTH, whose sad end at Loanda we mentioned last week, belonged to one of the oldest families of the Bavarian nobility. Although but thirty-one at the time of his death, he had already won a name by valuable researches on the nature of the Swiss glaciers, and by geological investigations in various parts of Europe.

FOR a number of years the University of Jena has been unable from lack of funds to meet the demands of modern university education, by the increase of professorships, establishment of scientific collections, &c. So severe has been the check upon the growth of the institution, that its friends have finally set on foot energetic measures to obtain a large increase in the annual grants from the various grand ducal governments upon which it depends for support. Saxe-Weimar has already promised an addition of 40,000 marks, and it is probable that this historic university will soon be relieved from its embarrassments.

WE regret to announce the death of the eminent surgeon, Sir William Fergusson, Bart., on Saturday last, in his sixty-ninth year.

WORK is about to be commenced on the new buildings for the University of Strasburg. They will be situated to the north-east of the City, with which they will be connected by a broad promenade, and will provide accommodation for about 1,500 students. The Government grant for the purpose amounts to 4½ millions of marks.

THE Hunterian Oration at the Royal College of Surgeons was delivered on Tuesday by Sir James Paget, in presence of the Prince of Wales, and a large and brilliant company. Sir James sketched the career, and pointed out the quantity, the wide range, and importance of the work done by Hunter.

AS Prof. Kirchoff refused the directorship of the Sun Observatory at Berlin, a Committee of Direction has been appointed, consisting of Professors Kirchhoff, Förster, and Awers.

AMONG the Bills to be brought before Parliament this session is one by Mr. Hardy "to make further provision respecting the Universities of Oxford and Cambridge, and the colleges therein."

ON Thursday last, Prof. Alexander Agassiz, who has been on a visit to this country for the purpose of investigating the results of the *Challenger* Expedition, embarked at Liverpool on board the White Star steamer *Britannic* on his return home. On the Wednesday evening he was entertained at dinner by the members of the Liverpool Art Club, and on Thursday, after visiting the Library and Museum of this town he was invited by the Mayor to lunch with the members of the library and museum committee at the town hall.

DR. N. v. KONKOLY, the director of the O. Gyalla Observatory in Hungary, is at present engaged in an extensive series of observations upon the spectra of the fixed stars. In the February session of the Hungarian Academy of Sciences he gave the results obtained with 160 stars. Vogel's division into three typical classes, white, yellow, and red, is followed. An interesting observation was made upon β Lyræ. The bright bands in its spectrum detected by Vogel in 1871 have now entirely disappeared, and were probably due to an astral protuberance. The same astronomer laid also before the Academy a carefully prepared record of all shooting stars observed in Hungary during the past six years. Their number amounts to about 2,000.

LORD NORTHBROOK has presented to Oxford University a valuable collection of skins of the game birds of India, collected for him by Mr. A. O. Hume, C.B., a distinguished Indian ornithologist. Lord Northbrook, in a letter to Dr. Acland, assures him that the collection is very perfect, if not unique.

A SINGULAR case has been tried at Paris. A manufacturer of gelatine complained that the water supplied by the new city waterworks was too good for him, and that he could not continue the manufacture of his gelatine. He claimed about 3,000*l.* damages, but his suit was dismissed with costs.

AT the next session of the French Association for the Advancement of Science, in August, the Geological Society of Normandy will organise an exhibition of all the geological and palæontological products of the five departments which compose that old province.

WE have received the first two numbers of a new monthly Italian journal, *Ellettricita*. It is published at Florence.

WE regret that our space only admits of our acknowledging the receipt of the *Proceedings* of the Liverpool Literary and Philosophical Society for 1875-6. This volume, like many of its predecessors, contains a considerable number of papers of real value in various departments of science. Messrs. Longmans and Co., are the London publishers.

THE Report of the Committee of the East Kent Natural History Society contains some forcible remarks on the condition of provincial museums in the same direction as those of Prof. Boyd Dawkins, which we reported some weeks ago. It is shown that the rates now squandered in support of those miscellaneous and motley gatherings, and incoherent medleys vaguely called museums, would suffice for the formation and mainten-

ance of museums worthily so named, and admirably adapted by judicious selection and arrangement to forward the education of our youth, and the direction of all classes of the people in the study of natural science. But, so far from promoting this worthy end, the managers of many provincial museums seem to understand nothing more than the establishment of unmeaning curiosity shops, better fitted to amaze the eyes and puzzle the brains of the groundlings, than to convey rational amusement and instruction to the people. Thus the study of the sciences of natural history is rather retarded than advanced, and the prevailing ignorance maintained and confirmed. Local museums should be adapted to the best mental culture. They ought to have a few good preparations, whether exotic or native, to exhibit plainly the general principles of nature, and systematic sets of many specimens to display particularly the natural history of the district; while the needless and grievous expense of room and money, caused by the acquisition and preservation of a gallimaufry of unsuitable objects, should be most strictly avoided. The rapid spread of knowledge, the report states, will soon convince the rate-paying public that their rates should be expended with at least some regard to the instruction of the rising generation. We sincerely hope so.

UNDER the heading, "Can Birds Count?" Mr. C. W. Wade, of Magdalen College, Oxford, writes as follows:—"I have often noticed that crows crowded on Sundays to a certain place, where, on the seventh day a friend of mine was in the habit of amusing himself by placing a quantity of broken biscuit on his window-sill; he had time for this only on the Sunday morning, and during the week no food was so presented. We noticed that on the Sundays a crowd of the birds came about the window, whereas on other days no special sign of excitement was visible among them. The opinion I formed of their power to count the days as they passed has been strengthened by hearing the following story." Mr. Wade then states that a gentleman much troubled by the depredation of crows built a shed at a distance from his house, where he took up position with gun and ammunition. After the first shot the crows would not return, so the gentleman took a friend with him to the shed and then sent him away, he himself remaining; but the crows kept out of range. Taking others with him up to the number of twelve, and sending them off separately, the result was the same. At thirteen, however, the crows seem to have lost count, and returned. To be fully credible the account ought to be first-hand, as it is not, and based on a regular series of experiments.

ANY information on the prospects of the future supplies to this country of Russian boxwood is a matter of some importance, therefore it is interesting, if not entirely satisfactory, to read in a recent report from Poti, the port from whence the bulk of the boxwood is shipped, that, though considerable quantities are still exported, it becomes annually worse in quality, and the supply for shipment at Poti must soon be exhausted. The export from the Abkassian forests is still prohibited by the Russian Government, but it is said that this restriction will shortly be removed. The writer of the report referred to describes a journey he made in 1873, through splendid forests of Normandy pine, birch, beech, oak, chestnut, walnut, and boxwood. With the opening of these forests it is estimated there will be a plentiful supply of prime boxwood for about fifteen years, after which that of inferior quality must be resorted to, as in Mingrelia. Boxwood, it seems, has also become quite recently an article of commerce from Taganrog to France and England; about 4,000 tons were shipped to these two countries during the year 1875, at a cost of from 8*l.* to 10*l.* per ton, free on board. This boxwood is drawn from Persian territory, on the southern coast of the Caspian Sea, across which it is conveyed to Astrachan, thence up the Volga to Tzaritzin, whence it passed over to Kalatch, on the Don, for Rostoff and Taganrog.

No. 7, concluding vol. ii. series ii. (Science) of the *Proceedings of the Royal Irish Academy*, has just been published. It contains a report on Irish Hepaticæ, by Dr. David Moore; a revision of the species of Abies of Endlicher and Parlatore, and Pseudotsuga of Carrière and Bertrand, by Prof. M'Nab; contribution to the history of Dolomite, by Mr. E. Hardman; on Glucinum, by Prof. E. Reynolds; on the chemical changes in potato disease, by Rev. Prof. Jellett; on remains of *Cervus megaceros*, by G. Porte; on the detection and precipitation of phosphoric acid by ammonic molybdate, by A. N. M'Alpine; on the product of the squares of the differences of the roots of a cubic equation, by Prof. Young; and on a new genus and species of sponge, by Prof. E. P. Wright.

THE February session of the Berlin Geographical Society was devoted to detailed reports from the lately-returned African explorers, Dr. Pogge and Dr. Lenz. The former described his journey from Angola to Mossumbu, the chief town of the Watajombas, whose existence has hitherto been regarded as mythical. The difficulties of the route were few, and the climate in the interior healthful. Dr. Pogge's experience would seem to point out his route as one of the most desirable for future expeditions to use in attempting to reach the interior of the continent. Dr. Pogge stated his belief that the Casai or Casabi is the Upper Congo, and that the Lualaba flows into the Ogovai. A letter in Tuesday's *Times*, from an Angola paper, written by a Portuguese merchant, is of the same tenor. It states that a Portuguese, whose name is not given, has found the source of the Zaire, twenty days' march east from Malange, and one day's march from the capital of Dumbo Tembo. The river is known as Casai or Casabi till it crosses the country of Lunda, when it gets the name of Nzare. Livingstone, in a letter dated Cassangé, February 13, 1855, mentions the common belief there that the Casai and Quango join to the north of Cassangé, and form the Zaire or Congo. We seem to be getting near the solution of the problem. Dr. Lenz, at the same meeting, sketched rapidly the results of his three years' wanderings among the Oskebas of the Ogowai district, by whose assistance he was also able, although with the greatest difficulty, to penetrate to the Adooma land, and touch his farthest point to the east, Banjska. The interesting results of his anthropological and ethnological studies among the Oskebas, we hope to give more fully.

ON Monday evening, Gen. R. Strachey gave the first of a series of lectures on Scientific Geography at the Geographical Society. He traced the progress of Geographical Science, pointed out the wide field embraced by it at the present day, and showed its aims and its importance.

THE annual meeting of the American Geographical Society was held on January 16, Rev. H. W. Bellows, D.D., in the chair. The annual election of officers and members of the Council was held. Chief-Justice Daly was re-elected president, and delivered his annual address on the Geographical Work of the World for 1876. The address, of which an early copy has been forwarded to us, is one of great interest, and contains a comprehensive view of geographical work during 1876 in all departments and in all parts of the world. Mr. Daly criticises with some severity various statements as to previous explorers in the Report of Sir George Nares. He commends the plan proposed by Dr. Hayes some years ago, of carrying on polar exploration by establishing a station at Port Ffoulke, a plan substantially the same as that proposed by Capt. Howgate of the U.S. Signal Service, to which we referred in a recent number. Mr. Daly mentions the interesting fact that the first Geographical Society was probably that founded in Venice in 1688, under the name of "Society of Argonauts," followed a few years later by an association of the same kind established at Nuremberg. For English

readers one of the most valuable parts of this address is the account of the work of the various U.S. Surveys for 1876. We regret that space prevents us doing more than referring to this interesting address.

AT the last session of the Berlin Academy a letter was read from Dr. J. M. Hildebrandt, travelling under the auspices of the Academy, who on December 10 was preparing to leave Mombassa, in Zanzibar, for an extensive expedition in the Kibuyn land. The chief aim of the undertaking will be to study the snowy regions of the lofty chain of mountains bordering on the coast-land. One of the first efforts will be directed to scaling the lofty summit of the Kenia.

Die Natur for February 12 contains a paper by Karl Emil Jung, "On the Family Conditions of the Australian Natives," in which he states some facts with regard to their marriage customs that deserve the attention of ethnologists.

No. 3 of the *Bulletin Trimestriel* of the Cairo Geographical Society contains a paper by Dr. Güssfeld on his exploration in West Africa, and a paper of great value by Col. Colston giving the results of his observations among the Bedouins of Sudan and Kordofan. Accompanying letters from Col. Gordon, which have been referred to by us already, are four maps of the course of the Nile in the region of the great lakes.

WE have received a copy of a lecture on the English Arctic Expedition given at the Scientific Club, Vienna, by Dr. Chavanne, forming one of a series of cheap popular scientific lectures which are being published by A. Hartleben, of Vienna.

SEVEN weekly meetings of the Cambridge University Natural Science Club were held during the last (October) term, when the following papers were read:—"On Analogies between the Senses in Man," by J. Allen (St. John's); "The Pectoral and Pelvic Girdles," by T. W. Bridge, B.A. (Trinity); "The Probable Age of the Earth," by E. B. Sargant (Trinity); "Caves," by J. E. Marr (St. John's); "The General Anatomy and Functions of the Cerebrum," by O. A. Browne, B.A. (Trinity); "Fermentation," by A. Hill (Downing); "The Chemical Composition of the Albumenoids," by S. H. Vines, B.A. (Christ's). Seven meetings are arranged to take place during the present (Lent) term. There are nineteen members in residence.

PROF. OGDEN ROOD has called attention (*Am. Journ. of Sci. and Arts*) to some cases in his own experience, which, along with an experience described by Tait, seem to prove that our retinal apparatus for reception of waves of light of medium length is more liable to be strained by nervous shocks or by prolonged excitation, than that designed for reception of waves of greater or less length. Thus nervous derangement and prolonged excitation may produce temporary green colour blindness. The effects Prof. Rood observed were in recovering from effects of chloroform, exposure to bright white light out of doors (when white objects seemed at first purplish red), and convalescence from typhoid fever (when white objects appeared of a weak orange yellow).

THE works in connection with the Paris Exhibition of 1878 are progressing with surprising activity. The buildings, which must be ready in the end of March by contract, will be completed before the appointed time.

IN the February Session of the Wurtemberg Anthropological Society, a somewhat novel communication was presented by Prof. v. Zech, the statistician of the Society. He instituted a careful comparison between the returns of the late parliamentary election and the anthropological statistics of the kingdom collected during the past year. The majorities of the government party were invariably obtained in districts where light-coloured hair and eyes predominate. The *Schwarzen*, the Ultramontanes, formed a medium class with regard to complexion, &c., and were not recruited from among the black-haired and the black-eyed, who seemed on the contrary to be the champions of social democracy.

THE *American Naturalist* for February contains an Account of the Natural History of the Fanning Group of Islands, by Dr. T. H. Streets. These are four coral islands in the Pacific, stretching from 1° 57′ N. to 5° 49′ N., and from 157° 27′ to 162° 11′ W. They do not seem to have been yet grouped on any chart.

A SECOND edition, revised to December 31, 1876, has been published of the "Catalogue of the Publications of the United States Geological and Geographical Survey of the Territories." Since 1867, forty-one publications have been issued, besides twenty-five maps. A considerable list of works in process of publication and in preparation is also given.

AT the meeting of the Brighton and Sussex Natural History Society, held on the 8th inst., an interesting paper by Miss Crane was read, "On Certain Genera of Living Fish and their Fossil Affinities." It is reported in full in the *Sussex Daily News* of February 10.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Master R. Wallace; two Chinese Geese (*Anser cygnoides*) from China, presented by Mr. A. H. Medhurst; a Common Raven (*Corvus corax*), European, presented by Mrs. Nathan; a Common Magpie (*Pica caudata*), European, presented by Miss Jessie Bovill; a Rough-legged Buzzard (*Archibuteo lagopus*), European, presented by Mr. W. R. Paxton; a Common Marmoset (*Hapale jacchus*) from Brazil, a Common Paradoxure (*Paradoxurus typus*) from India, deposited; two Maned Geese (*Bernicla jubata*) from Australia, a Red-vented Cockatoo (*Cacatua philippinarum*) from the Philippine Isles, purchased.

SCIENTIFIC SERIALS

IN the January number of the *Quarterly Journal of Microscopical Science* we find that Dr. Klein has superseded Dr. Payne, as one of the editors. Mr. H. N. Moseley has two valuable papers, the first on the colouring matter of various animals, and especially of deep sea forms dredged by H.M.S. *Challenger*, in which a large number of fresh band-producing colours from sponges, Coelenterata, Echinoderms, Annulosa, and Mollusca are described with figures of their spectra. In the second, *Stylochus pelagicus*, a new species of Pelagic Planarian, is described, with notes on other pelagic species, together with the larval forms of Thysanzoon, and of a gymnostomatous Pteropod.—Dr. Klein, in a note on a method of preparing the cornea by the employment of caustic potash and lunar caustic.—Mr. Kidd describes Schiefferdecker's Microtome, and gives an epitome of a paper by Engelmann on "Contractility and Double Refraction."—Mr. Peek has an important paper on the minute structure of the gills of Lamellibranch molluscs, the investigation having been undertaken in the Histological Laboratory of Exeter College, Oxford, at the instigation of Prof. Lankester. The filamentary gills of *Arca* and *Mytilus* are shown to explain the nature of the more complicated organ in *Anodon*, the most simple type being filaments bent on themselves at their middle points, outwards for the outer gills, and inwards for the inner, so that in section they form a W.—The last paper is a *résumé*, by Mr. Archer, of recent contributions to our knowledge of freshwater Rhizopoda.

Journal de Physique, January.—On the phenomena of induction, by M. Mouton.—Chromatic polarisation of tufts in biaxial crystals, by M. Maré.—Note on the experiment of the Franklin portrait; a new glass breaker, by M. Barat.—On absorption of radiant heat by aqueous vapour, by M. Hagu.—Note on the employment and choice of spectacles designed to correct bad vision, by M. Dubois.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, February 8.—Mr. C. W. Merrifield, F.R.S., vice-president, in the chair.—The following communications were made to the Society:—On the area of the quadrangle formed by the four points of intersection of two conics, by C. Leudesdorf.—A certain series, by Mr. J. W. L. Glaisher, F.R.S.—The differential equation $\frac{dx}{\sqrt{X}} + \frac{dy}{\sqrt{Y}} = 0$, by Prof. Cayley, F.R.S.—On the classification of loci, and a theorem in residuation, by Prof. Clifford, F.R.S.

Zoological Society, February 6.—Osbert Salvin, F.R.S., in the chair.—Mr. Sclater exhibited and made remarks on some unnoticed characters in the original and unique specimen of Comrie's Manucode (*Manucodia comrii*, P.Z.S., 1876, p. 459).—Mr. Howard Saunders exhibited a specimen of the Panay Sooty Tern (*Sterna anæstheta*), which had been obtained on the English Coast, and was the first recorded occurrence of this bird in the British Islands.—Dr. A. Günther, F.R.S., read a memoir on the tortoises collected by Commander Cookson, R.N., during the visit of H.M.S. *Peterel* to the Galapagos Islands. The main results of Commander Cookson's visit consisted in giving us a knowledge of the tortoise of Abingdon Island (*Testudo abingdoni*) and of the tortoise of the north of Albemarle Island (*T. microphyes*).—A communication was read from Mr. Robert Collett containing an account of his observations on *Phylloscopus borealis*, as met with on the coast of the Varanger Fjord and adjacent parts of Finmark.—Mr. Sclater read a note on an apparently new species of spur-winged goose of the genus *Plectropterus*, proposed to be called *P. niger*, founded on two examples living in the Society's Gardens, which had been presented to the Society by Lieut.-Gen. A. V. Cunningham.—Prof. A. H. Garrod read a paper on the mechanism of the intervertebral substance and on some effects resulting from the erect position of man.—A communication was read from Sir Victor Brooke, containing notes on the small rusine deer of the Philippine Islands, and giving the description of a new species proposed to be called *Cervus nigricans*, of which a female example was recently living in the Society's Gardens.—A paper by Mr. O. Salvin and Mr. Ducane Godman was read giving the description of twelve new species and a new genus of butterflies from Central America.—Dr. Günther gave an account of the zoological collection made during the visit of H.M.S. *Peterel* to the Galapagos Islands, which had been worked out by himself and his assistants in the Zoological Department of the British Museum.—Mr. R. B. Sharpe communicated the description of a new species of pheasant of the genus *Lobiophasis* and of a new species of *Pitta* from the Lawas River, North-west Borneo. Mr. Sharpe proposed to call the former *L. castaneicaudatus*, and the Pitta, *Pitta ussheri*.

Geological Society, January 10.—Prof. P. Martin Duncan, F.R.S., president, in the chair.—Frederick Tendron and David Thomas were elected Fellows, and Dr. J. F. Brandt, of St. Petersburg, Dr. C. W. Gümbel, of Munich, and Prof. Eduard Suess, of Vienna, Foreign Members of the Society.—On gigantic land-tortoises and a small fresh-water species from the ossiferous caverns of Malta, together with a list of the fossil fauna, and a note on Chelonian remains from the rock-cavities of Gibraltar, by A. Leith Adams, F.R.S., Professor of Zoology in the Royal College of Science, Dublin. The author described three distinct species of tortoises from the Maltese rock-cavities, one of which was of gigantic proportions, and equalled in size any of the living or extinct land Chelonians from the Indian or Pacific Islands. The characteristic peculiarity in the two larger species is a greater robustness of the long bones as compared with the denizens of the Mascarene and Galapagos Islands, with which he had been enabled to contrast them. The largest, on that account, he had named *T. robusta*; it rivalled the gigantic *Testudo ephippium* (Günther) in size, showing affinities to it in a few minor characters. A smaller species, *T. Sprattii*, and a small *Lutremys*, not distinguishable, as far as the few remains extend, from the recent *L. europæa*, besides many fragments of shields of tortoises of various dimensions, had been obtained. These Chelonians were found in conjunction with the remains of the dwarf elephants and other members of the remarkable fauna, collected by Admiral Spratt and the author in the ossiferous rock-cavities of Zebbug, Mnaidra, Benghisa, &c. The paper contained a list of the animal remains hitherto recorded from the Maltese fissure caverns, including three species of dwarf elephants, two species of *Hippopotamus*, two gigantic species of *Myoxus*, a gigantic swan, and other animal remains; and further, a Note on some Chelonian remains from the rock-fissures of Gibraltar.—On the Corallian rocks of England," by the Rev. J. F. Blake, F.G.S., and W. H. Hudleston, F.G.S. The object of the paper was to describe the rock masses existing between the Oxford and Kimmeridge clays as exhibited throughout England. They occur in five distinct areas which were treated separately. Where best developed, as in Yorkshire and at Weymouth, the series is much more varied than the usual nomenclature indicates; in both instances a lower mass of limestone, distinct from that representing the "coral rag" of Central England, is present. In Yorkshire, especially, this limestone is of great importance, and is separated by a "middle calc. grit" from the upper limestone series. These upper limestones were also shown to be separable into two very distinct divisions, especially by their fauna, viz., the "coralline oolite" and "coral rag," which last term is here applied in a restricted sense only to true coral-bearing or inter-coralline beds. The upper beds, called "supra-coralline," were shown, where present, to be of great interest and importance—and their fauna was for the first time indicated—and the ironores of Abbotsbury and Westbury were proved to belong to this portion of the series. The fauna of the Corallian rocks was shown to be very markedly Oxfordian in the lower portions, and equally Kimmeridgian in the upper, while but a limited portion only could be said to have a fauna of its own. The whole series was deposited in lenticular masses of traceable size.

Physical Society, February 3.—Prof. G. C. Foster, president, in the chair.—The following candidate was elected a member of the Society:—Mr. J. Norman Lockyer, F.R.S.—Prof. Osborne Reynolds exhibited a number of experiments in relation to vortex motion in fluids. They have been gradually developed during the last few years, but are still in a very incomplete state, and he hopes that others will join him in the inquiry. Probably one reason why so little progress has been made in the determination of the elementary laws of fluid-motion is that mathematicians have been without experimental data on which to found their calculations. The well-known rings formed by puffs of smoke have been studied by many high authorities, but not with a view to their general bearing on this subject. Prof. Reynolds first showed smoke rings and their interference by means of the apparatus devised by Prof. Tait, and added that although the theory of smoke rings does not imply that vortex motion is peculiar to vapours, their existence in liquids was only pointed out by Mr. H. Deacon at a comparatively recent date. In studying the action of the screw-propeller, Prof. Reynolds noticed the systematic manner in which the form of a disc moved obliquely through water is retained by the track of air which it produces. If a flat disc be supported on a light frame and caused to move rapidly through water the motion ceases on withdrawing the hand suddenly; but if this be done gradually the motion continues. By passing a coloured liquid down a fine tube to the back of the disc, he found that a vortex ring is always formed, which passes to the rear of the disc, and the same effect is produced by dropping water from a height into water covered with a coloured liquid. In a trough about six feet long and at one end of which was a horizontal tube closed with sheet india-rubber, air rings were formed by introducing air into the tube and then striking the india-rubber externally by means of a flat board, and it was shown that a ring is capable of propelling a vane placed in its course, to the front of which it never advances. If the air be replaced by a coloured liquid the ring travels with considerable velocity and the motion of a solid body of the density of water is in no degree comparable. If a ring travels through a part of a liquid which has previously been coloured, it causes no motion of translation, and Prof. Reynolds concludes that no resistance is offered to their motion. Nevertheless the motion is gradually stopped, but the ring is constantly enlarging by gathering water as it travels, and its momentum remains nearly constant. After adverting to the methods adopted to ascertain the direction and velocity of motion, the initial form of the rings was shown to be a spheroid. A solid of this form, however, is very slow in its passage through water, and he considers this to be due to friction. He has succeeded in imitating the form of the ring by causing a disc, surrounded by pieces of ribbon, to move through water. Finally, Prof. Reynolds referred to Sir William Thomson's researches on the interference of two rings, and showed that the oscillating rings so produced can be formed in liquids or gases by employing an oval in place of a circular aperture.—The Annual General Meeting of the Society

was then held.—The president read the report of the Council, of which the following is a brief abstract:—The Council points with satisfaction to the number and interest of the papers read before the Society, and a brief summary is given of the more important. The Society has to regret the loss of three of its members, Mr. David Forbes, F.R.S., Mr. A. S. Hobson, and Mr. Arthur Pinn. The publication of a new edition of Prof. Everett's work and of a complete edition of Sir Charles Wheatstone's writings is announced, and the Council hopes shortly to undertake the translation of scientific papers from foreign sources to be published in its proceedings.—The following Officers and Council were elected for the ensuing year:—President, Prof. G. C. Foster, F.R.S. Vice-Presidents: Profs. W. G. Adams, F.R.S., and J. H. Gladstone, F.R.S, Mr. W. Spottiswoode, LL.D., F.R.S., Sir W. Thomson, LL.D., F.R.S., and Dr. W. H. Stone. Secretaries: Prof. A. W. Reinold and W. C. Roberts, F.R.S. Treasurer, Dr. E. Atkinson. Demonstrator, Prof. F. Guthrie, F.R.S. Other Members of Council: Prof. W. F. Barrett, Latimer Clark, Major Festing, W. Huggins, D.C.L., F.R.S., Prof. Kennedy, O. J. Lodge, Prof. H. MacLeod, Prof. B. Stewart, LL.D., F.R.S., Prof. Unwin, and E. O. W. Whitehouse.—The proceedings terminated with votes of thanks to the Lords of the Committee of Council on Education for the use of the Physical Laboratory at South Kensington and to the several officers of the Society.

Royal Microscopical Society, February 7.—Anniversary meeting.—H. C. Sorby, F.R.S., president, in the chair.—The president delivered the annual address, in which, after reference to the memory of those of their number deceased during the past year, he gave an interesting account of his recent researches into the composition and origin of the loose materials which form the sands and clays of this country, and also of those composing the sandstones and stratified rocks.—The result of the ballot for officers and council for the ensuing year was as follows:—President, Mr. H. C. Sorby. Vice-presidents: Dr. L. S. Beale, Sir John Lubbock, Bart., Rev. W. H. Dallinger, and Mr. H. Powell. Treasurer, Mr. John W. Stephenson. Hon. Secretaries: Mr. H. J. Slack and Mr. Chas. Stewart. Council: Dr. Robert Braithwaite, Dr. Lawson, Dr. Millar, Messrs. Bevington, Brooke, F. Crisp, Ingpen, E. W. Jones, Loy, M'Intyre, Thos. Palmer, and F. H. Ward. Assistant Secretary, Mr. Walter W. Reeves.

Institution of Civil Engineers, February 6.—Mr. George Robert Stephenson, president, in the chair.—The paper read was on "The Sewage Question," by Mr. C. Norman Bazalgette.

Rome

R. Accademia dei Lincei, January 7.—Second appendix to memoir on the construction, properties, and applications of a constant inductor, by M. Volpicelli.—On complete elliptic integrals, by Prof. Smith.—On the small oscillations of an entirely free rigid body, by M. Cerruti.—On the anatomy and physiology of the retina (continued), by M. Franz Boll.—On the spinal medulla and the electric lobe of the torpedo, by M. Reichenheim.—Geological studies on the group of the Gran Paradiso.—Rational catalogue of the rocks of Friuli, by M. Taramelli.

Paris

Academy of Sciences, February 5.—M. Peligot in the chair.—M. Duchartre presented the second and last part of the second edition of his "Éléments de Botanique." The following papers were read:—On the fundamental invariants of the binary form of the eighth degree, by Prof. Sylvester.—Preliminaries of a comparative study of living and fossil European oaks; definition of present races, by M. De Saporta.—On monochlorised oxide of methyl, by M. Friedel.—Composition and origin of diamantiferous sand of Du Toit's Pan, in South Africa, by M. Meunier. Geologists have assigned a deep origin, representing them as the residue of alteration of pyrogenous rocks emitted like lava. The author's analysis gives, besides minerals proper, a number of complex rocks which cannot have been formed at once in the state of mixture by the same causes. Each of them must have been removed from a special deposit, then carried to the point where mixture took place. These sands belong to the so-called *vertical alluvia*, and are related in formation to the Kaolinic sands in the environs of Paris.—On the preparation and use of the liquid for washing vines attacked by Phylloxera, by M. Boiteau.—MM. André and Angot expressed a desire to be sent to San Francisco to observe the transit of Mercury on May 5, 1878. They hope thus to render the study of the next Venus transit more fruitful.—Diathermaneity of metals and of paper, by M. Aymonnet. They are not athermanous, as generally thought. They are more diathermanous for dark heat from metallic bodies raised to a temperature under 100° than for luminous calorific radiations or those near red. They have weaker absorbent powers than water. It is possible to find a mathematical relation between the absorbent power of a body and its coefficient of conductivity.—Note on the presence of ammonia in cast steel, by M. Regnard. Ingots of steel newly broken gave a distinct smell of ammonia, with perceptible noise in escape of the gas, and bubbles in soapy water if applied. The appearance of the fracture in all such cases was crystalline, varying slightly from periphery to centre; the liberation was greatest at centre. Soft steels in general did not give the phenomenon, nor did ingots previously annealed. Analysis of the gas showed it to be nearly pure hydrogen, with perhaps a few traces of acetylene.—On the active principle of *Strophantus hispidus*, or Inee, by MM. Hardy and Gallois. This is the plant used by the Pahonias in poisoning their arrows. The isolated body, called *ineine*, has not the same physiological properties as *Strophantine* (so-called by Fraser). Injected in considerable quantity under the skin of a frog's foot, it does not stop the heart's movements.—Immediate disorders produced by injections of pure fuchsine into the blood, by MM. Feltz and Ritter. The nervous disorders, like those of drunkenness, cannot, the authors now think, be due to embolic lesion (in the capillaries), but to direct impression of the nervous system by the fuchsine itself.—Structure and mineralogical composition of variolite of Durance, by M. Michel Levy. The globules of variolite are not petro-silicious. By its petrographic affinities it seems to be a compact term of the series of euphotides. It presents an interesting association of several varieties of amphibole and pyroxene; also a new example of spherolites entirely crystallised.—On the intestinal anguillule (*Anguillula intestinalis*), a new nematoid worm found by Dr. Normand in persons attacked by diarrhœa of Cochin China, by M. Bavay. It is distinct from, and much less abundant than, the *Anguillula stercoralis*.—On the minute phenomena of fecundation, by M. Fol. All the phenomena are reduced to two typical cases.—On *Filaria hematica* (Hæmatozoa), by MM. Galeb and Pourquier. The authors found filaria in the blood of the fœtus of a bitch whose heart was teeming with them; the embryos doubtless passed through from mother to offspring. This explanation destroys the idea of verminous diathesis, and of spontaneous generation, called in to explain the genesis of such hæmatozoa. The authors also verify M. Davaine's view that the nematoid worms circulating in the vessels of certain dogs are larvæ of the hæmatic filaria.—Determination of ammonia in the air and in meteoric waters at Montsouris, by M. Levy.—On two new species of Ibis, from Cambodge, by M. Oustalet.—On a new sounding-line, by M. Tardieu.

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