THE

EDINBURGH NEW

PHILOSOPHICAL JOURNAL.

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EDINBURGH NEW PHILOSOPHICAL JOURNAL,

EXHIBITING A VIEW OF THE

PROGRESSIVE DISCOVERIES AND IMPROVEMENTS

IN THE

SCIENCES AND THE ARTS.

CONDUCTED BY

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On Artificial Quartz—Llamas and Alpacas in Holland—Diseases arising during the manufacture of Brussels Lace.

Paris Academy of Sciences.—Dec. 6.—M. Ebelmen submitted to the Academy some specimens of artificial quartz. Amongst them are some to which he has given various tints by mixing colouring substances with the silicic acid. The specimens impregnated with chloruret of gold are remarkably beautiful. At the end of a certain time the chloruret of gold is decomposed, and streaks of gold appear in the entire mass. The decomposition is accelerated by the action of the solar light, and under its influence also bright colours are obtained—sometimes blue, sometimes red, and sometimes violet. By a modification of his process, M. Ebelmen obtains a true natural mineral, the *hydrophane.* It is a siliceous, porous, and opaque substance, which becomes perfectly diaphanous as soon as it is plunged in water. M. Ebelmen has ascertained that this substance absorbs gases as powerfully as charcoal.—A communication was received from M. Christian Bonafoux, giving an account of the attempt made, by order of the King of Holland, to acclimatize the llamas and alpacas of Chili. Four years ago thirty-four of these animals, males and females, were imported into Holland, and put into the royal park, Scheviningen, near the Hague, where they have propagated freely. The climate does them no injury, and they merely seek the shelter prepared for them when there is snow on the ground.—M. Gaudichaud laid before the Academy his opinion on the disease which has lately been so destructive to the potato.—M. Blanchet gave an account of the serious consequences resulting from the process of whitening Brussels lace to the persons employed in it. In this process the carbonate of lead is used; and a large portion of it is carried into the atmosphere, where it is inhaled, and thus produces a serious affection of the intestines. It is also very injurious to the sight and to the hearing.—M. Leroy D'Etiolles submitted a new and improved lithotritic instrument.—*Athenæum,* No. 1051, p. 1306.

MISS F. CORBAUX'S *Coloured Map of Egypt will be given in next Number.*

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TO CORRESPONDENTS.

We regret that the very interesting letters on Dolomization, addressed to M. De Beaumont, by M. De Morlot, and sent by the author to us through Dr Boue, did not reach Edinburgh in time for the present number of our Journal.

ERRATA.

Page 82 line 34, *for* was to seen *read* was seen, or, was to be seen
83 — 37, *for* on which *read* in which
84 — 5, *for* 80° *read* 18°
88 bottom line, *for* or 8 or 9 miles *read* and 8 or 9 miles
89 — *for* such little appearance *read* such appearance

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An Attempt to classify the Phenomena in the Glens of Lochaber with those of the Diluvium, or Drift, which covers the face of the Country. By Sir G. S. MACKENZIE, Bart., F.R.S., V.P.R.S.E., &c. With a Map. Communicated by the Author.

THE notion respecting the origin of the terraces or shelves in the Glens of Lochaber, which was entertained on their being first discovered, viz :—that they were productions of art, is scarcely worthy of being mentioned, except for the purpose of remarking as singular, that they still retain the name of "the Parallel Roads," indicating that the impression of their being artificial had been exceedingly strong. When it came to be universally admitted that the formation of the shelves was natural, and that the operating power had been water, difficulties presented themselves in every inquiry into the mode in which the water had been brought to act, and into that by which it had been removed. Geologists are as far from coming to an agreement as ever; and the interest in the phenomena is reviving.

It is now more than twelve years since I briefly announced in Sir David Brewster's Philosophical Journal, a new explanation of the origin of these terraces, which occurred to me during a conversation with him, when he resided on the banks of the Spey. In January, 1842, I read a more extended account of my views before the Royal Society of Edinburgh, in which I noticed Mr Darwin's theory; but I delayed to publish my observations, in the expectation of being able to collect additional facts to support my ideas. During the time that has since elapsed, the observations of geologists of the travelled and water-worn materials which so abundantly cover the globe, have been considerably extended; and the results have contributed to confirm me in the belief that my explanation was well-founded. Mr David Milne has made an extensive and careful examination of the Lochaber phenomena, and has given the result of it to the public in the Transactions of the Royal Society of Edinburgh, and in Jameson's Journal. As all that he has decribed appears to me to favour my own views, a nearer approach to truth may be made, if I now submit these views to the consideration of those who take an interest in the discussion.

Every one who proposes a new theory being bound to shew that preceding ones are insufficient, Mr Milne has entirely set aside that of Mr Darwin. I should not, therefore, now notice the theory of the latter gentleman, were it not to point out that an objection he stated, unfounded, against mine, is applicable to his own, though it has been received with much favour by the English geologists; and perhaps the ease with which he rejects the theories of others, without taking the trouble to disprove them, may have contributed to gain the favour of those who are more accustomed to the simple effort of describing facts, than to the more complicated one of accounting for them. Mr Darwin appealed to Dr MacCulloch's elaborate argument to shew that no sudden change could have taken place in their formation; and against the objection that, as the shelves were separated from each other by considerable distances, a sudden movement in the rising of the land was necessary to the formation of each shelf, Mr Darwin affirmed that the force which acted upwards *pushed up only the space occupied by the shelves*, and, of course, he imagines it to have been so carefully regulated as to preserve them unbroken. If the space including these shelves had been exclusively elevated somewhere about 1300 feet above the level of the sea, it is singular that Mr Darwin did not seek for, find, and point out, the boundary of the elevated space, since it ought to stand out clear of the surrounding country from which it had been separated. One would imagine, that the shock necessary for such a separation would have effectually disturbed, if not obliterated, the parallel shelves. How Mr Darwin could adopt such an idea, after affirming that no sudden change could have taken place, I am at a loss to understand.

Mr Milne's theory requires a more detailed examination; and, fully sensible of this, I went to Lochaber shortly after his paper was read before the Royal Society of Edinburgh; and while I found a confirmation of the objections that had occurred, I met with nothing which did not appear to confirm my own views. I am not, however, so unphilosophically wedded to them as to imagine they will withstand the assaults which the observation of others may enable them to make on them. At all events, the time has not yet come for the final settlement of any physico-geological question.

Mr Milne goes back to a period long antecedent to the formation of the shelves, in order to pave the way for them; and if I have not rightly understood him, the fault must rest with me; for, both in conversation and correspondence, he has, with the greatest readiness, answered every question. He has, too, materially helped in the construction of the map, so that by its assistace both of us may be better understood than we would have been without it.

Mr Milne assumes—

1. That our island had been submerged in the ocean, where it acquired its present aspect.

2. That during the period of submergence, the hollows between the mountains were filled with boulder clay, gravel, sand, mud, &c.

3. That after the hollows were filled the land began to rise.

These three conditions are preliminary to the action by which the existence of the shelves is attempted to be explained. They involve some important considerations, rendering some special hypothesis necessary for their explanation. We may pass over the first assumption; but the second seems to require some consideration before it can be admitted as a postulate. The hollows between the mountains are all filled up; and the mass of loose matter employed for that purpose is far too great for being collected by any ordinary natural cause. We see indications of great violence in the rounding of large boulders, and in the reduction of rock to the state of gravel and sand. To render his theory complete, Mr Milne should, perhaps, have instructed us whence, and by what means, the loose materials were brought to fill up the valleys. An appeal has no doubt been made to oceanic currents. I am not, however, aware of any known current that proceeds at such a rate as to enable it to carry boulders and gravel along with it. An extraordinary force appearing requisite, its nature and origin should have been explained, before its effects were assumed hypothetically. In Mr Milne's paper, on page 410 of the 16th volume of the Transactions of the Royal Society of Edinburgh, and page 355 of Jameson's Journal for July and October 1847, we find him thus expressing himself:—"These facts, taken in connection with the undoubted fact that detrital matter has been spread over Scotland, to a height of at least 1500 feet above the sea, pretty clearly indicate that detrital matter not only may have been, but actually was spread over the Lochaber district, and filled its several valleys to the height of at least the highest of the Glen-Roy shelves, thus affording ample blockage for its lakes."

We have now an extensive mountainous district under the sea, having its valleys filled with detritus to a specified elevation. It is next to be raised out of the water by a process so carefully managed, that the levels and parallelism of the shelves, to be formed one after the other as the land rose, were not to be disturbed. Supposing the land elevated to the height necessary to lay the surface of the detritus dry, we have then a desert plain, extending some hundreds of square miles. We may next suppose that water issued from some points of the higher ground, to the amount of the existing streams, and inquire to what quarter it was to flow in order to join the sea? According to the theory under examination, the valleys were filled up with detritus to the height of the highest shelf; consequently, there could be no hollows for the formation of lakes, when the land was raised so as to expose the surface of the detritus. Mr Milne has not pointed out any limit to the detritus. The water, however, would find its way to whatever point of the compass the surface might lean, and however tortuous the course.

Every one who has observed the action of rivers on loose materials knows that when a stream flows over an extended surface, it cuts but little away, until it comes to an edge or slope; and then it cuts backwards, throwing before it such loose matter as it has power to move. This process is incompatible with the formation of a lake. To form a shelf, there must have been a considerable depth of water under the line of surface where it was to be shaped out; but in the case before us there could be no such thing.

Such, I conceive, to be the simple mechanical result of Mr Milne's filling the valleys with detritus. He makes no provision for hollows to form lakes; but he evidently assumes them, though inconsistently with the statement with which he sets out. But I am not disposed thus to limit the theory in question. I will admit that there were hollows left free when the detritus filled the rest of the country. I will take Glen-Roy as an example, and suppose that the detritus extended but a little way up the Glen, all the rest being empty.

Now, while the land was submerged, according to Mr Milne's hypothesis, what is now Glen-Roy must have formed part of the bottom of the sea; and we cannot doubt that, in such a case, it would be inhabited by marine animals common to the latitude. It is obvious that when the land rose above the level of the sea, Glen-Roy would be, at first, a salt water lake, and the creatures inhabiting it would be caught, as it were, in a trap. The fresh water running into this lake would gradually free it from salt, and the animals would perish. As the process of emptying the lakes is supposed by Mr Milne to have been gradual, the remains of these animals, bones and shells, being uninjured and undisturbed, ought to have been left behind in sufficient quantity to indicate the catastrophe that had befallen them, just as we find such exuviæ in what are called elevated sea-beaches. Nothing of the kind has hitherto been observed.

The chief difficulty which to me appears to meet Mr Milne's theory is, how to get rid of the enormous mass of materials which he has accummulated. For, to produce the shelves, to clear the country so as to make it present its existing aspect, by the means which nature has placed at his command, seems to me an utter impossibility. There never could have been any means consistent with his theory, other than the waters issuing from the district. The Great Glen which is supposed to have been filled along with the others, presents a special difficulty in the great depth of its lakes. How this glen, and the basins of the lakes were cleared out, Mr Milne leaves us to conjecture. Until they were cleared out, there was nothing to direct us to the point where the Lochaber streams might have reached the sea; and their courses are not unimportant to his theory. If we suppose the clearing of the Great Glen to have been accomplished as far as its present relative position to the level of the sea, it would still remain to shovel out the detritus from its lake basins, to the depth of some six or seven hundred feet; to a depth, indeed, exceeding that of the North Sea.

The foundation of Mr Milne's theory does not admit of barriers placed here and there as occasion might require. The whole was filled with detritus to the height of the highest shelf, which must have been the highest level of the supposed lake; and if we admit of lakes at all, the water in them must have been retained by a fall or slope of the great mass covering the whole country. Let us, however, imagine a barrier extending a mile or two across a valley, and of breadth proportioned to its height. The operation of a stream, such as that of the Roy, commencing its work at the top of the barrier, would be to cut from the edge of the outer slope backwards. After the cutting had proceeded to a certain depth, the sides would fall in, giving the stream additional labour to perform. This would, in course of time, be repeated, till the slope of the sides became sufficiently low to prevent their falling in. Following out, then, the simple mechanical operation of water on masses of loose matter, and considering the immense amount of such matter assumed by Mr Milne, we must conclude that some traces of that accumulation, and some unequivocal marks of the progress of the streams should have remained to this day, as well as the shelves. No such traces or marks appear; and I deny the possibility of clearing the country of the assumed mass of detritus, so as to give its present aspect, by the means which nature has furnished. Supposing that such a mass had existed, it may be asked, what has become of it? Have the streams of the district such power as to warrant the idea that they carried it back to the region whence it was brought? I cannot think that any one who has seen them, even in a state of flood, will answer in the affirmative.

I now proceed to state what I have long entertained as the most probable cause of the production of the shelves.

It is now admitted, I may say almost universally, that the evidence of water having flowed over the land, and in this country in a direction from between west and north to between east and south, is complete. As we find detritus deposited at fully 1500 feet above the sea, the water which carried it must have had its surface greatly more elevated. Some suppose, as Mr Milne, that this deposition took place while the surface was under the ocean. The permanency and parallelism of the Lochaber shelves, together with all the phenomena of the diluvium or drift, including the absence of marine exuviæ from the latter, persuade me irresistibly, that when they were formed, the land had acquired its present general relative position to the level of the sea; admitting, nevertheless, that partial and local, though not extensive, gradual elevations may have taken place. Every one who has given attention to what goes on at the bottom of rivers, on the margins of lakes, in estuaries, and on the sea coast, knows that loose matter may assume under water various forms, often fantastic, according to the direction, force, and interference of currents with each other. The observations made during a long series of years have not led me to swerve from the conviction, that, after the land had assumed its present aspect and position in relation to the sea, or at the time when the land was broken up into its present condition, a vast body of water has passed over it. It is little short of half a century since Sir James Hall made me acquainted with the facts which led him to the conclusions which he published in the Edinburgh Transactions; and nothing I have seen or been informed of since has contributed to change my views in reference to his conclusions; though in regard to many other points of geology, I may declare, as the last survivor of the old Huttonian school, that I have seen ample reason to call in other agents, besides those employed by that school, to account for them.

The apparent difficulty of assigning a cause for such a flood as the debacle theory assumed, has probably deterred many from adopting it. But a careful examination of effects, and a patient investigation of their modifications, during the *subsidence* of such a flood, by the local configuration of the land, might satisfy every observing mind that the flood had occurred, whatever might have been its cause. We are satisfied with many things without pursuing a chain of causation at all. Any one meeting with a stream of cold lava, or a mountain composed of cinders and slags, though unacquainted with volcanic phenomena, concludes at once that heat had dealt with them. So when we meet water-worn masses at great elevations, we are satisfied that water had brought them to their resting-place ; and we do not inquire either for the cause of heat in the one case, or whence the water had come in the other. In reference to our present subject, it is not impossible to assign a cause sufficient to raise a wave vast enough to break over the highest portions of our island. On this subject I read a paper to the Royal Society of Edinburgh, in February 1847 ; but it is unnecessary to enter into the subject at present, farther than to state that, from various facts which have presented themselves to their knowledge, several of our most eminent geologists have expressed their conviction that a continent existed in the space now occupied by the Atlantic Ocean, of which the British islands, the Faroe islands, and Iceland are remnants. The sudden sinking of much less than the whole of such a continent, could be shewn to be sufficient to raise a wave of ample dimensions to break and flow over the British Islands, and to extend its influence much farther. Assuming then that such a flood as the debacle theory assumes had happened, I will now endeavour to shew why I am of opinion that the shelves of Lochaber are proofs of that theory.

Assuming what has in reality been proved, that the quarter from whence the wave proceeded was as mentioned above, let us carefully attend to a *most important peculiarity* connected with the Lochaber glens, and which suggested the theory to which I have been so long attached. It will be observed, on inspecting the map, that Glen-Gluoy opens into the Great Glen, its streams flowing into Loch-Lochy. Glen-Roy, including its offsets, opens into Glen-Spean, and the latter opens towards the Great Glen.

The next fact to be kept in view is, that the Great Glen is at a right angle with the direction of the flood, being NE. and SW., the flood having passed from NW. to SE.

Let us now suppose the flood passing over the land. As soon as it subsided below the mountain tops, it would necessarily be divided into currents and eddies, taking courses into which the water would be forced by the opposing elevations; and this circumstance should be kept in mind, when the forms and position of drift matter are contemplated. When the waters had subsided a little below the summit level between Glen-Gluoy and Glen-Roy (1, on map, Plate I.), the former would become, not precisely a lake, but an arm of the waters, protected on all sides from violent agitation, and in a condition to form the upper shelf, No. 1. which we find coincident with the summit level. While the waters flowed over this level into Glen-Roy, no shelf could have been formed on account of the violence with which the water advanced.

The waters continuing to subside, as soon as the summit level between Glen-Roy and the valley of the Spey (2.) became exposed, this glen would become an extensive, and well protected arm of the waters; and, accordingly, we find No. 2 formed a very little way below the second summit level. I may here remark that the shelves should be found to terminate near to the locality where it would appear the waters continued to be greatly agitated; and this is seen to be the case.

Mr Milne, during his active researches, discovered a summit-level between the head of Glen-Glaster (3.), (a glen overlooked by former observers,) and Glen-Spean; and shelf No. 3, which had been a stumbling-block, is now found in circumstances precisely similar to those above it, in relation to the summit-level.

The next summit-level (No 4.) is that which separates Glen-Spean, and all the comparatively low country extending from the eastern side of Ben Nevis to the mountains forming the glens in question, from Strathspey. When the waters had subsided below this level, all this district would be filled with water little agitated, except in the vicinity of the Great Glen, through which the waters must have continued to flow both towards the NE. and SW. Accordingly, we find shelf No. 4. commencing at the summit-level, and stretching towards the Great Glen, disappearing where we may presume the waters were too much agitated to admit the formation of a shelf. It should be observed that whenever the flow of water over a summit-level ceased, the subsidence of the waters would be checked for a time, they having to take a new and circuitous course, and thus ample time would be afforded for the formation of a shelf.

Mr Darwin has remarked the probability that the formation of the shelves was somehow connected with these summit-levels ; and it appears to me that there cannot be a doubt of the fact, that the nature of the connection is as I have stated. It is clearly more natural that the waters had subsided to the levels, than that the land was raised from the sea ; for, in the latter case, it would have been necessary to lift the land to a certain point, and then stop until the first shelf was formed ; then to lift it again rapidly that no formation should take place during the interval, and to stop till the next shelf was formed ; and so on—a process not likely to preserve the levels. It must be remarked, too, that the shelves are not shaped precisely as if the matter forming them had been deposited by water in a state of absolute rest. Their upper surfaces slope downwards, and the edges are rounded off to the steeper slope, indicating the action of waves of considerable power.

We have now seen the effects of the peculiarities of the locality of Lochaber on the waters of the great flood, forcing it to leave behind it traces of its action, having very marked relations among themselves. These are altogether independent of the effects of the flood in other localities (not having similar peculiarities,) where we find the effects, as indicated by the drift, to be precisely what we should expect from the courses which the water must have taken through the valleys, and from the eddies caused by the meetings of currents. Wherever glens may exist having the same peculiarities, in reference to the direction of the great flood, there we may expect to find similar shelves. Partial appearances of shelves may be seen here and there, which may not exactly accord with the circumstances of those in Lochaber. But when we contemplate the operations of such a flood as has been supposed, and consider that its movements over the uneven surface, and through the sinuosities of the land, must have subjected it, and the materials carried along by it, to very variable conditions, we may reasonably expect to find effects which cannot instantly be accounted for. Many of the terraces we find in valleys have been formed in a manner different from the operation of waves throwing materials against a slope. It appears in many places that the gravel, sand, and boulders have been deposited in the valleys so as to leave a flat surface. As the waters subsided and formed powerful streams, this flat surface has been cut through, and much of what had been deposited carried away, leaving flats, more or less extensive, with faces sloping towards the streams.

Another probable result of the passage of the flood may be considered, in reference to those portions of the island towards the eastern coast, which are open and comparatively free of mountainous elevations. In such localities the waters must have spread out, still, however, flowing and eddying in its general direction, and retaining its general level. Of this level, in its variations in elevation, wherever we may suppose the water to have been more quiet, (as it must have been in the Lochaber glens) we may expect to find traces. If in the North Highlands and elsewhere there be spaces over which the waters could spread, and be less agitated; or glens, such as those of Lochaber, or others in which they were confined, their general level and its traces would be the same in all similar localities, though distant from each other.

I have only farther to observe, in reference to the attempted assimilation of the shelves and terraces we have been considering to sea-beaches, by Mr Darwin and others, that the materials composing the former are the same with those composing the general diluvium or drift; whereas *existing* sea-beaches—those formed, and forming under our eyes, are very differently compounded, and generally different in form. If any ordinary beach, on which the sea now operates, can be shewn to possess characters in all respects the same with the Glen-Roy shelves, and other shelves and terraces, then there will be an end of the question. No advocate of the beach theory has ever attempted this, so far as I know. That shells may have been deposited by the operation of the great flood at considerable elevations, and whales thrown upon the land in some localities on the east coast where their exuviæ had been found, I think may be shewn. Yet I by no means deny the existence of facts tending to demonstrate the partial elevation of the land. I myself saw, many years ago, while wandering among the sandhills near Forres, and probably about ten or twelve feet above the sea, a beach which was recognisable at a glance. But I must still maintain that the sea-beach possesses characters that plainly distinguish it from shelves of diluvium. Until they be proved identical, the theory of raised beaches, as applied to the Lochaber and other shelves, cannot be supported. This proof is the very first thing to be given to provide a foundation for the theory. When it is made known where the proof is to be seen, I will, if at all able, gladly travel to see it, and with sincere pleasure will acknowledge it.

I will conclude by remarking, that, if the conjecture be correct (as I hold it to be) that a great Atlantic Continent has disappeared, and that the British Islands are remnants of it, one effect of sinking would necessarily have been to lower the general level of the ocean. This would afford means of explaining the phenomena of what have been called *raised* sea-beaches; only the title would have to be changed, the sea having left them.

Should these surmises meet the eyes of American geologists, they may consider whether the sinking of an Atlantic Continent, and the consequent production of an enormous wave, can account for the diluvial terraces in the western hemisphere. The component parts of the diluvium in America should, in such a case, be nearly similar to those of the European; for the loose matter in both must have been, in great part, derived from the sunken surface.

On the Comparative Physical Geography of the Arabian Frontier of Egypt, at the earliest epoch of Egyptian history, and at the present time. By Miss Fanny Corbaux. With Two Plates. Communicated by the Authoress.

The sections (Plate V.,) are constructed from the measurements of the French Scientific Survey, for which *vide* Descr. de l'Egypte, Et Mod., vol. xi., Journal du Nivellement de l'Isthme. The degrees of the levelling operations are retained in the diagram, to facilitate reference. They consist of French feet, inches, and lines, reckoning downwards from an imaginary standard point, 150 feet above the high-water mark at Suez. The measures and calculations in the memoir always suppose French feet, when it is not otherwise stated. This is to avoid the confusion likely to arise from the use of two different standards. Twelve French feet are about equal to thirteen English.

A comparative scale of the perpendicular and horizontal measurements is given in the plate. In such a delineation, one cannot avoid giving a very exaggerated idea of the *heights* as compared with the *distances* of the respective points. To obtain a section on a true proportional scale, it would be necessary to make it about 1500 times as long as the engraving, the height remaining the same.

Introduction.

The geography of a country is often the index of its history. Its physical peculiarities exercise a sensible influence in forming the manners, customs, and character of its inhabitants, and in regulating their internal and external policy. This was peculiarly the case with ancient Egypt. Hemmed in on all sides by natural barriers which no hostile neighbour could overpass, we find all her historical remains testifying how, from the remotest antiquity, she had cultivated the arts of peace. The numerous Syrian tribes beyond her frontier had not time to become nations. They wasted their energies in mutual strife for small tracts of land; Egypt looked on, attacked them, and seized the prize they were contending for; took to herself the lands and souls of her captives, and made them the tools of her pride, in recording their own degradation on the walls of the gigantic monuments reared by their forced labours.

On one side only was this favoured country open to foreign intrusion; her *Arabian frontier*. It seems to have been the persevering aim of the rest of Egypt for centuries, to gain possession of this tract, and to expel its early colonists, tribes nearly allied to the Egyptians in blood, but who maintained their simple pastoral habits and hardy independence to the last. A race, who not only were able to resist Egypt for several centuries, but even to subdue a considerable part of that country for a time, as is recorded of these shepherd people, must have been numerous; and their country could not then have been the sandy, barren, and marshy desert that we now find it. It must have possessed some very important resources and advantages; for it was only *after* the expulsion and dispersion of this people, that the power of Egypt began to be felt externally, and soon reached its highest pitch of eminence. Her commercial and military ascendency only then passed the limits of her river, and began to exert its influence over the rest of the known world. Not long afterwards, the family of the patriarch Jacob went to settle in Egypt. The country of "the Goshen" must then have been very different from what it appears to be, since Joseph availed himself of the inveterate prejudices of the Egyptians, which extended even to the land their dangerous and hated adversaries had so long occupied, and to the manner of life they had led, to obtain its rich pastures as a settlement for his beloved family.*

In fact, unless we admit that very considerable physical changes have taken place on the face of this important district, the frontier state of Egypt, the ancient LAND OF GOSHEN, we can form no idea of its position and boundaries, its agricultural, commercial, and pastoral advantages, and its commanding position as a military state, in the remote ages of early Egyptian history. For it is in the very regions on the primitive condition of which its chief value as a settlement depended, that it will be found to have undergone a thorough revolution.

It was in the hope of throwing additional light on some of the doubts and difficulties attaching to a few early passages of Egyptian history, that the succeeding inquiry was entered upon. The principal event of which that land was the scene, in those remote ages, is one that has a sacred

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* *Vide* Gen. xlvi., 33, 34; xlvii., 6, 11.

and universal interest in the eyes of all to whom the Holy Scriptures are the history of religion. It was the place of refuge of the Hebrew Church for more than two centuries; and, in the days of her temporary oppression, the momentous events of her deliverance and Exodus were enacted there. Yet the scenes of those events have hitherto remained a matter of doubt and unsupported conjecture!

The great difficulty which Biblical critics encounter in their attempts to refer the events of the Mosaic account of the Exodus to any definite localities, arises from their having framed their hypotheses from the land *as it is now*, without taking into account the probable extent of the changes wrought in its physical geography,—partly by the slow, but certain operations of nature,—partly, as we shall have reason to discover, by the interference of man. Those only who are correctly informed concerning the actual state of the country, can estimate the formidable difficulty of reconciling the Mosaic narrative with such positions as its present topography affords. The few detached and unsupported conjectures, wholly at variance with each other, hitherto published on the geography of the Exodus, attest both the extent of this difficulty, and the doubtful success of every attempt to propose a theory on the subject. Before we can judge whether the account of Moses can be made to square with the topography of the land through which he led the host under his guidance;—before we can appreciate, as a subject so sacred and important deserves, the *extraordinary geographical accuracy of the minute detail* included in that account;—we must go back 3500 years, and restore the land to its primitive condition, by inquiring into the changes that may have been effected in it since then, by determining their period, and ascertaining their causes.

The results of an inquiry to this effect are embodied in the map.* It differs in four essential points from any former attempt to illustrate the geography of the Mosaic period.

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* See Plate IV.

1°. In the limits of the Red Sea, which has retired 30 miles from its former head.

2°. In the Mediterranean coast region, where nearly 25 miles of land beyond the shore have been converted into a large lake and barren unhealthy marshes.

3°. In the region of the river, where, besides restoring to their primitive position the branches of the Nile known to have changed their course or become extinct, I have introduced another branch, unknown to ancient geography, and situated on the frontier, to the east of the Pelusiac; it is marked on the map as the ETHAM *branch.*

4°. It differs in the position of the cities and sites enumerated by the Sacred historian as the stations of encampment.

In our common Bible-maps, these stations are generally placed at random along the line of desert between Cairo and Suez. This distance, owing to the difficulty of the route, would amount to a four days' journey for such a multitude, encumbered with goods, children, and cattle; and there is not a spring or a well all the way. So that a track along that road is *physically impossible.*

Dr E. Robinson* has seen this difficulty, without obviating it. He proposes another plan, liable to objections almost as serious as those he has sought to avoid, and that are fatal to his hypothesis. He places "RAMESES," the starting-point of the assembled multitude, in the Valley of Seven Wells, where there is a ruin of a former frontier-city; and proposes to bring the Hebrew host to Suez by coasting the (so-called) Bitter Lakes. But as two days of this journey would be equally destitute of water, the indifferent wells at Ajrûd being then the only supply, the difficulty is not sufficiently lessened by this hypothesis to counterbalance the unquestionable claim of the ruin he takes for "RAMESES," to represent quite a different place, the "*Hero*" of the Antonine itinerary, the position of which,—in respect of several other sites enumerated in this itinerary, and all exactly corresponding

* Biblical Researches in Palestine, &c., by E. Robinson, D.D., and the Rev. Eli Smith, vol. i., p. 74–86.

with existing ruins,—is too well fixed by this correspondence to admit of doubt or controversy.* And if this be the celebrated *maritime* city known to ancient geography as *Heroum*, *Heroon*, and *Heroopolis*,† which it would be absurd to

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* All the roads introduced in the map are comprehended in the subjoined extracts from the Itinerary of Antoninus. As the roads are graduated in Roman miles, according to the scale, the cities they lead to will be easily found; and (with only one exception, Tasacarta) correspond to ruins still to be seen.

ROAD I. From Pelusium to Memphis.

Pelusio to Daphne,* M.P., xvi.,—to Tasacarta, xviii.,—to Thou, xxiv.,—to Scenas Veteranorum, xxvi.,—to Heliu, xiv.,—to Memphi, xxiv.

* *Remark.*—The position of *Tel Defenneh*, the remains of Daphne, enable us to detect and rectify an error—probably of copy—a deficient x in the Roman numerals. *Tel Defenneh* is exactly xxvi. M.P. from *Farama*, the remains of Pelusium.

ROAD II. From the Serapeum to Pelusium.

Serapiu to Thaubasio, M.P. viii.,—to Silæ,* xxviii.,—to Magdolo, xii.,—to Pelusio, xii.

* *Remark.*—There is here another error analogous to the above; a redundant x in the Roman numerals, which the ruins enable us to rectify. The distance between the vestiges of Silæ and Thaubasio is xviii. M.P.

ROAD III. From Babylon to Clysmo.

Babylon to Heliu, M.P. xii.,—to Scenas Veteranorum, xviii.* (some copies have xvii.),—to Vico Judæorum, xii.—to Thou, xii.,—to Hero, xxiv.,—to Serapiu, xviii.,—to Clysma, L.

* *Remark.*—Two slight discrepancies in this road may be easily removed by the position of the ruins, which correspond exactly with the distances assigned to them by Road I. The xvii. M.P., which some copies have, between Heliu and Scenæ, seem a copyist's error for xiiii. And, since there are xxvi. M.P. between Scenæ and Thou, as well by the ruins as by Road I.,—and the true distance between Scenæ and the intermediate station, Vicus Judæorum, is nearly xii. M.P., in which the present road coincides with the ruins,—it follows that there ought to be more than xii. between Vicus Judæorum and Thou, and that the repetition of xii. here must be a copyist's error. The real distance, by the ruins, is a little above xiv., which exactly makes up the total of xxvi. to Thou.

ROAD IV. Part of road from Gaza to Alexandria.

Pelusio to Heracleus, M.P. xxii.,—to Tanis, xxv.,—to Thmuis, xxii.,—to Cyno, xxv., &c.

† Strabo renders the name of this city by των Ηρωων πολις, of which "*City of Heroes*" seems the literal translation. Hero or Heron was an Egyptian god. It is possible that the Egyptian name, the true orthography of which is unknown, might have had a plural termination, that led this geographer into what rather appears, than is, an error, as this form given to the proper name may be only *emphatic*, no notion of plurality being necessarily intended. The corresponding Hebrew name Hiroth has likewise a *fem. plural* termination. A curious mistake of the Septuagint may fairly be adduced in proof that, when this version was made, a city known to them as Hiroth existed in Egypt on the road to Palestine, and that it was called in

doubt;—and further, if the said "*Hero*" be indentical with the HIROTH of Scripture, a place which, from the last encampment near it being called "Pi-ha-hiroth," must have also been *near the Sea*,—and which the result of this inquiry will prove really was the case, it will be evident that the site thus chosen by Dr Robinson for the *starting-point*, must in fact have been near the *end of the journey*.

Mr Sharpe, in his History of Egypt (vol. i., pp. 30–32), proposes another hypothesis. By an ingenious etymological analysis, he identifies the principal stations of the Mosaic account, by name, with certain cities on one of the lines of the road particularized by the above mentioned itinerary.

This theory further supposes the Arabian Gulf to have occupied at that time the site of the saline marshes, generally —but, as we shall hereafter find, erroneously—supposed to be the "Bitter Lakes" of Strabo's geography. Thus the last encampment at Pi-ha-hiroth, might *then* have been near the sea, though that site is now nearly 35 miles from it.

It is a very satisfactory coincidence in support of the positions thus suggested by Mr Sharpe, that the researches of MM. Dubois-Aymé and Le Père* led them to conclude, on the best physical and historical grounds, that the extent of the Red Sea, *up to beyond the time of Herodotus*, had been such as he had conjecturally assigned to it. This view was approved by all the contemporaneous scientific men excepting M. Rozière, who pleaded a physical objection† to this

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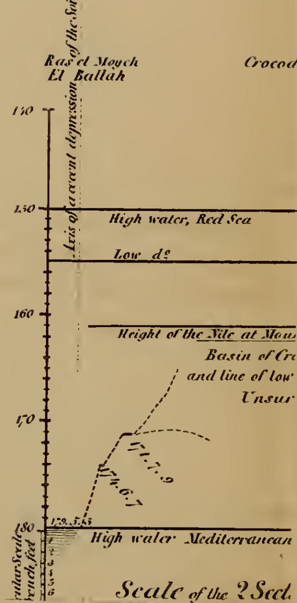
Greek Heroopolis. The translators appear to have read from a MS. in which (Gen. xlvi., 28) the first two letters of the infinitive *horoth* הורת "*to guide or direct*" being imperfectly formed, looked like הירת '*Hiroth ;* which they accordingly rendered by "Heroopolis." Josephus, following this reading, informs us that Jacob sent Judah to meet Joseph at Heroopolis in Goshen. The Septuagint translators would hardly have committed this mistake, had no such city existed in that situation; for the false reading would have been obvious, and thay would have rectified it. To have read any other word than "*horoth,* i.e., *to direct,*" would have made the entire passage unmeaning.

* Descr. de l'Egypte. Et Mod., vol. xi.

† Descr. de l'Eg. Ant., vol. vi., p. 272. M. Rozière supposed the low plateau (marked "Pi-ha-hiroth" in the map) in the centre of the Isthmus to be *lower* than the Red Sea (*Vide* also sect. i.); and as the whole valley of the canal, and nearly all the Delta, are also much lower, he urged, that if in historical times

Plate V.



Axis of a recent depression of the Soil
Ras el Moyeh
El Ballah
Crocod
140
150
High water, Red Sea
Low d°
160
Height of the Nile at Mou
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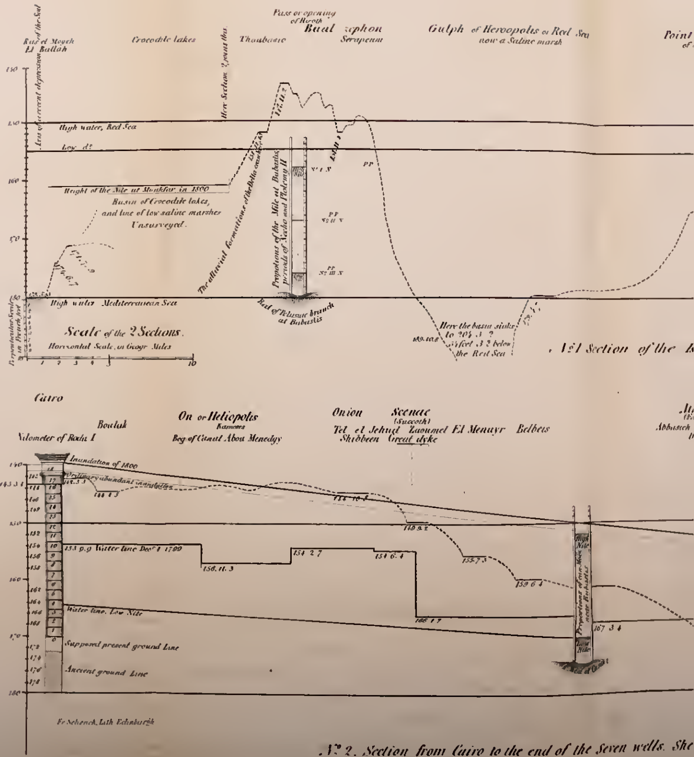
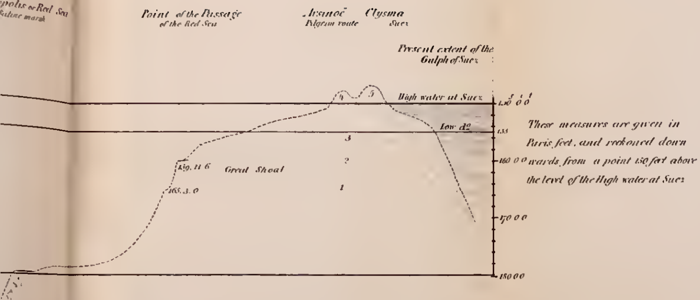
Unsur
170
171.7.9
174.6.7
179.3.65
180
High water Mediterranean
Scale of the 2 Sect.

Plate V

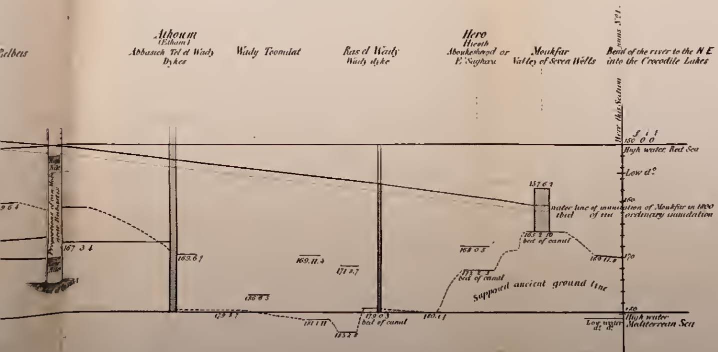


No 1 Section of the Is…

No 2. Section from Cairo to the end of the Seven wells. She…



. N°1 Section of the Isthmus of Suez, by the Crocodile lakes, to Ras el Moyeh el Ballah



end of the Seven wells. Shewing the course of an ancient arm of the Nile theory, which was most satisfactorily refuted by MM. Le Père and Dubois-Aymé; who produced the results of actual measurements in their appendix. Descr. de l'Eg. vol. xviii., Pt. i.

A brief sketch of the physical structure of the Isthmus of Suez, may here be of interest to such as are not familiar with the characteristic features of this remarkable though inhospitable tract. The survey of Messrs J. M. and G. Le Père, St Genis, and Chabrol,* furnishes the data for the diagram illustrating this subject, Section No, 1. shewing the line of the lowest points across the Isthmus of Suez, from the present head of the Gulf to the north side of the plateau in question. This line is the bottom of a valley, flanked on both sides by a table-land of barren rock and sand. It forms an irregular trough, *lower than the Red Sea* in every part, excepting two low plateaus of very small extent. Both of these were once only shoals extending across a narrow strait,† along which the Mediterranean and Red Seas mingled their waters, which then had the same level. At some period more remote than historical records can reach, the gradual elevation of the land must have brought up the central shoal to eight feet above the water's surface, by which a natural dyke, about five miles across, was formed, separating the two seas. The *northern half of the Isthmus*, and *the whole Delta*, owe their existence as dry land to the formation of this barrier. For, the Mediterranean having thereby become a large in-

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the Red Sea had reached the limits assigned to it by MM. Dubois-Aymé and Le Père, it would have gone farther, and submerged all lower Egypt. He therefore concludes of the theory "C'est une hypothèse; tandis que *l'abaissement* du plateau est *un fait positif;* en effet, qu' importe le reste?"

In answer to M. Rozière, M. Le Père gave the measurement of every station of the survey across this plateau, 12 in number, proving that it *rises* 8 *feet above* the highest tides of the Red Sea; so that the *elevation* of that critical point, and not its *depression*, is the "*fait positif.*" Thus the sea could, and did, for perhaps thousands of years, reach that limit, without the disastrous effects predicted by M. Rozière. The result of these measurements are given in the section No. I., where the principal stations only are delineated. On so small a scale, more detail would have produced confusion.

* Descr. de l'Egypte, Et Mod., vol. xi., and App., vol. xviii., pt. i. The line of both sections is coloured on the map.

† Lyell's Pr. of Geology, book ii., p. 1., chap. viii.

land gulf, subject to a greater evaporation than the current that sets in from the Straits of Gibraltar can replace,* its waters sank, at the eastern end, to a permanent level of equilibrium between these two opposite agencies,—which is about 30 feet lower than the Red Sea at high water.

It is evident that this central plateau must have continued to form the northern boundary of the Red Sea, until another shoal, near Suez, was raised above the water's edge by the simple process of accumulation, forming a second natural dyke across the gulf, that stopped out the water from the upper gulf-basin, and left a hollow nearly 60 feet deep, which became a salt lake, and is now a dangerous marsh. This second shoal begins about 20 geogr. miles south of the head of the former gulf, and its length, to near Suez, is about 11½ miles ;† but it is only a space about 2½ miles of its southern end that is actually *higher* than the sea; beyond this, it slopes downwards about 10 feet to the edge of the upper gulf-basin. The process by which the surface of this shoal was raised to its present height, may be seen still going on in the Red Sea. The coral banks that grow up rapidly in its shallows, rise to the low-water mark; and then the lithophytes cease their operations. The enormous quantities of drift-sand, blown into the shallow gulf, are washed up by the waves, and deposited, with broken shells and gravel, on the top of these shoals; where, from the quantity of calcareous matter which the water of this sea contains, they form hard banks up to the high-water level. It was at the foot of a height on which Ptolemy Philadelphus built the marine station of *Arsinoë*, that a line of sand-banks began to form on a shoal of this description, at its southern end, the one most exposed to the winter-tides, which are always 3 or 4 feet higher at that season, because then the prevailing winds blow from the south. It will be seen by the section that this end of the bank is scarcely 3 feet above the ordinary winter high-water mark of the Red Sea, and only a few lines above its excessive tides in stormy seasons.

Thus far, Mr Sharpe's positions appeared to be sustained

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* Lyell's Pr. of Geology, book ii., p. 1., chap. vii.

† Its extent is indicated by a dotted line on the map, Plate IV.

by the coincidence of the Red Sea's former extent, *prior to the time of Herodotus.* But it was still open to the old and fatal objection that, in the time of Moses, there *was no visible supply of water* for those cities along which the Hebrews' route was supposed to pass; and that cities *could not exist without water.* The corresponding Egypto-Roman cities were on the banks of a canal, but the date of the construction of this work, the famous Red-Sea canal, is well fixed by history: it was only begun by Pharaoh-Necho, who lived 870 years after Moses. Some traditional accounts refer the commencement of the undertaking to "Sesostris;" but Sesostris is a fabulous personage. And though Sir Gardner Wilkinson* very judiciously argues, from a monument of Remeses II. being found at "*Hero*" on the canal, that this monarch may be the "Sesostris" referred to in this legendary account—and it is historically admitted that he cut numerous canals to drain and irrigate Lower Egypt—we are not helped out of the difficulty; since the most accredited chronological arrangements tend to place his reign about 200 years after Moses.

But when we consider that the principal Egyptian canals are only restorations of natural channels that have either moved off or died away, we are tempted to suspect that such may have been the case with this particular canal; and that if it was commenced only by Necho, or by Sesostris, it was because the natural stream did not fail till then. M. Lepère distinctly recognises tokens of the Nile having flowed in the valley of the canal, at some period unassignably remote. And as the inundations of the Nile are reported even now to penetrate occasionally far into the valley, such an hypothesis might appear very plausibly sustained. But the *possibility* of an hypothesis being true, is no proof that it *is* so. And to verify a geographical theory; to establish it as a fact that may in its turn be used in confirmation and illustration of history in general—and of sacred history in particular—we require *positive* evidences—*physical proofs.*

I therefore propose, in the succeeding dissertation, to de-

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* Modern Egypt and Thebes, vol. i., p. 312.

monstrate that such a boundary arm of the Nile did actually exist *at the time* of which the map is supposed to represent the geography, and that it was then the connecting link of a highly important chain of ancient Egyptian frontier cities and fortresses; among which will be found the places Mr Sharpe proposes to identify with the stations of the Mosaic itinerary.

As this inquiry involves a question entirely new to ancient geography, it will be necessary to enter upon a very minute consideration of the physical facts from which the proofs we require may be deduced, and of the historical details by which our conclusions appear to be supported.

The first step in this investigation will be, to study the line of this river's supposed course, in order to ascertain whether the present condition of the valley in which it ran affords a clue to the physical causes of its decay. A correct delineation of the present structure of the land, and its relation to the water-levels, is here the first desideratum. And for this, the invaluable data contained in the "Journal du Nivellement" of the French Commission—designed for the restoration of the ancient canal—furnish all the materials we require.

On the Ancient Frontier Channel of the Nile.

The section, No. 2, taken along the line of lowest points from Cairo to the end of the Valley of Seven Wells, in which are the Crocodile lakes, delineates the *present state* of the valley through which this ancient frontier channel had its course. In this section we have, as it were, the country itself before our eyes: we have both the means of arriving at a conclusion, and of judging whether it be supported by fact or not.*

This section exhibits a double series of levels along the whole line, to shew the relative positions of the land and the water.

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* The survey of this district was effected by Messrs Devilliers, Duchanoy, Fèvre, and Alibert. For the details of the measurement, &c., *vide* Descr. de l'Egypte, vol. xi.; Extrait du Journal du Nivellement. To avoid confusion, the leading and characteristic levels alone are indicated in the section.

From Cairo to Abbasieh, where the canals that are still open terminate, the principal and most significant levels are those of the *water's surface* along the canals early in December, that is, three months after the height of the inundation. Above this are seen a few leading points upon the banks, to shew the general elevation and form of the land itself along the edge of the water-courses. The points selected are:—near Boulak;—the foot of the "Tel el Jehud" mounds of "*Onion*" and "*Scenæ*," near Shibbeen;—and at Abbasieh near the vestiges of "ETHAM or Thoum," Here, the further course of the water is cut off by dykes. Beyond this point the level indicated by the dark dotted line is that of the bottom of "Wady Toomilat,*" at the extremity of which, "Ras el Wady" is another large dyke. We next come to the Valley of "Seven Wells;"† and, following the course of the ancient canal past two very remarkable ruins, that of HIROTH or *Hero*, and that of a commercial outpost or magazine belonging to it, about three miles distant, called "Moukfar" in the great French map, we find that the ground-line, after rising gradually from near *Hero* to *Moukfar*, suddenly sinks again, and the valley terminates in the large basin containing the Crocodile lakes.

Necho's canal ran along the north bank of the Wady Toomilat; and, besides the lowest ground-line, some points on the ruined dykes of this ancient canal are indicated, along the whole length of the valley, by a lighter dotted line.

As standards of comparison, I have introduced the nilometer of Roda in its place—the levels of the two seas—and also a diagram of the canal Moëz near Bubastis,‡ in order to shew the relative height and true proportions of its embankments, its bed, and its water at various seasons. All these are taken from Le Père's "Tableau des échelles comparatives," and adapted to the scale of the section. (*Vide* Plate xiv., Descr. de l'Egypte, vol. i. Et Mod.)

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* This is the modern name of the part of the valley between Abbasieh and "*Hero*."

† The remainder of the valley, to the Crocodile lakes inclusive.

‡ The Canal Moëz now occupies the site of the Tanitic branch of the Nile, from near Athribis to Zoan.

The first thing that strikes one as remarkable, in this section, is the *abrupt fall* of the water-line just beyond Tel el Jehud: and this would be much more remarkable, if the river had not already sunk to half its maximum height, when the measurements were taken. This reduced level continues along about twenty miles of canal, till the further progress of the water is arrested by the dykes of Tel el Wady near Abbasieh.—To irrigate the Wady, the water is occasionally let out as far as the great dyke at Ras el Wady, as all this part of the valley, and even the bed of the old canal, are cultivated ground; but this does not take place every year.

One cannot look at this sudden interruption of the water-line, in connection with the great depth of the valley beyond it, without suspecting that *some artificial restraint* must be employed to keep the water lower than the line of its natural flow; and that, without such restraint, a branch of the Nile would probably run along this valley at the present time.

The great inundation of 1800 proved this fact, and much besides, more conclusively than any argument. It fortunately happened while the survey by the French engineers was in progress, so that the results were observed and recorded by them. The Nile rose so rapidly to an unusual height, that it broke through its embankments, and filled the whole length of the valley to the Crocodile lakes. The depth of the water, between Abbasieh and Ras el Wady, varied from 15 to 25 Paris feet. Every road from Belbeis to the north was stopped, being rendered impassable for months, from the quantity of water, except at "Moukfar," where the bottom of the valley rises and its sides contract. There, the course of the water was confined to the bed of the ancient canal, which is in tolerably good preservation, though so much choked up by sand and alluvial matter that the depth of the water was only five feet; so that there was at that place *one fordable passage*. Beyond this spot, the water began to flow downward with a *very rapid current;* it filled the lagoons of the Crocodile lakes, passed through an opening at the north-eastern end of the basin enclosing the lakes, and there was lost in a line of low saline marshes that now extend northwards from these lakes to Lake Menzaleh.*

Now if we compare the height of the water at the nilometer of Roda Island during the inundation of that year, with the height it generally attains in an average favourable inundation, the difference is under eighteen inches.† Hence, it is quite clear that what happened in 1800, might happen every year, *minus* that small difference. As surely as water will run into a hollow and rise in it to its own level, so surely would the Nile run into this valley to this very day, and fill it annually to a considerable depth, if no restraint were imposed on its course. There would be about 14 feet (English) of water near Abbasieh,—and 24 at Ras el Wady, (as may be seen by the two upper slanting water-lines,—*Vide* section 2.) Even when the Nile is at its lowest point,—as indicated by the lower slanting line extending from the measurement of that point on the nilometer to the end of the valley,—there would be about 12 feet of water in the deep parts of the ancient river's course, nearly up to the spot where the vestiges of *Hero* are found. If the waters rose in the valley up to the point of 1800, once, it was through *an accident* by which, that once, the river was enabled to attain its natural level.

When we connect the *facts* brought to light by this irruption, with the construction of the valley as exhibited in the section, the inevitable conclusion thereby forced upon us is rather startling. For while we have before us physical proof that *art alone* prevents a considerable river from flowing in its natural channel to this day, it is equally certain that the

* [Those who wish to go over the very remarkable and interesting details of this inundation, will find the particulars,—Descr. de l'Egypte, Et Mod., vol. xi., pp. 82–86, Mém. sur le Canal des 2 Mers, by M. J. M. Le Père.—Appendix, vol. xviii., pp. 349–355, Mèm. M. Dubois-Aymé.—Extrait du Journal de M. Devilliers, ibid., pp. 379–382.—And vol. v. Ant., Descr. des Ant. de l'Isthme, by the same, p. 134–158.]

† The waters of 1800 rose to 30 Paris feet and a few inches above the point 0 of the nilometer, 3 digits above the 18th cubit over the capital of the column; and this measure is adapted to the scale of the levelling operations, in the section. A rise of 29 feet above the point 0 is regarded as the measure of an abundant inundation.

period when the restraint of art was first imposed on its waters, must be more remote than the most ancient historical records extant. For Herodotus mentions the *Pelusiac* branch, as being, in his time, the most eastern arm of the Nile. And one naturally asks, how so vast a work as cutting off in its prime a stream as deep and broad as any remaining secondary arm of the Nile, should ever have been undertaken ?—and also, when can it have been done ?—by whom ? and to what purpose ?

The bed of the ETHAM river offers some remarkable physical anomalies that are only to be accounted for by the manner of its formation. And as these may serve, in their turn, to lead us towards a satisfactory answer to these inquiries, we must look back a little, and consider what it was during the ante-historical period.

The ETHAM river does not appear to have been an ordinary Delta-channel along the whole of its course, hollowed out of the alluvial soil with an even and downward slope to the sea, like the other arms of the Nile. Part of its bed lay along the bottom of a valley in the rocky district out of the true Delta, and part of the bottom of this valley has a slope just the contrary way. This remarkable acclivity is to be seen at the spot called " Moukfar" (*vide* section 2), where it is highest; the slope upwards begins a little before *Hero*. Much of this is the result of recent accumulations of sand and alluvium in the most narrow and exposed part of the valley, but not *all*, as we shall hereafter have occasion to remark more particularly. A certain amount of inequality—a slight swell of ground all along the cleft in the rocks that form this remarkable valley,—must always have existed, forming a considerable impediment to the course of the Nile along it; so that the water, after it had reached *Hero*, had to rise above the level of the obstacle, before it could flow off through the valley by the downward passage already adverted to, which is a natural opening in the hills, in the direction of the northern marshy tract, and where the current, during the great flood of 1800, was so extremely rapid.

The general level of the ground, all along the valley, from near Belbeis to the Crocodile lakes, being much *lower* than the Red Sea; while the rocky plateau capped with sand-hills rises suddenly on both sides from 30 to 50 feet *above* it, shews us that, before the first central shoal in the strait that once separated Egypt from Arabia had risen to the water's edge, and parted the Mediterranean from the Red Sea the whole valley formed another narrow strait nearly at right angles to the first, so that the hilly tract north of the valley was a large island.

The sediment of the Nile being drifted into it, as in other contiguous parts of the sea, while the whole of the present Delta was yet under water, this part of the strait would end in having a smooth ground corresponding in level to the other parts of the Delta. So that afterwards, when the seas were divided by the rising of the central shoal,* and the waters of the Mediterranean began to evaporate, and the Nile began to send out arms towards the retiring sea in all possible directions, one of these arms might well make its way along the low ground of this valley, till it reached the point where the bottom of the strait had been originally higher than the Delta, which is near *Hero.* But over this natural obstacle, the water could not pass, at that remote epoch, when the Nile was low. For, as the soil at the apex of the Delta was then considerably lower than it is now, so the level of the water-line was proportionally lower. It was only during the inundation season that the river could attain a sufficient height to form a superficial current over this acclivity, so as to run into the basin of the Crocodile lakes,—and out of these again along the low marshy tract left by the retiring northern sea.

One consequence of this formation is, that the annual deposits of the Nile must, for a considerable part of the year, have been accumulated exclusively in the western half of the valley, known as Wady Toomilat. Indeed, at a remoter period than that represented by the map, this may have formed a long shallow lake, with a river flowing part of the year *into* it, and the other part *through* it. We cannot conclude any thing positive on this state of things, from the mere fact,

* At the spot marked Pi-ha-hiroth in the map.

that 15 feet of the alluvial soil have been dug through without reaching the bottom ;—because either all this, or more, or only a part of it, may be of submarine formation like the Delta ; and unless we could determine the precise period when the Mediterranean retired ; and had also an opportunity of subjecting the contents of the deposits to geological scrutiny, it would be fruitless to stop to conjecture how far the hollow between the two rocky plateaus that form the sides of the valley may have been filled up while yet under the sea ;—and how much the raising of its surface may be due to the subsequent depositions of such a lake as the Nile would form there, if the sea had retired before the hollow was filled up. And such a conjecture would be quite useless to the present inquiry, which requires nothing more than the undeniable physical fact, attested by the present form of the land as delineated in the section, that, whereas the *water-line* distinctly shews that the Nile must have run through the valley, and would do so still if it were allowed to have its own way ;—nevertheless, the *land-line* as distinctly shews, that when it ceased to flow in and through the valley, *it had not done so long enough to fill up the entire hollow.* For, considering the present depth of this hollow, compared with the height of the swell that terminates it, we must see that, had the river that flowed through it, been allowed to flow on, it must have continued open naturally, until its deposits had brought up its whole bed along the valley to the level of the obstacle. It must at last have made for itself an even and shallow bed with an insensible slope towards the sea, like that of the defunct Pelusiac. The form of the valley alone compels us to conclude, that, if the river has ceased to flow there, it cannot have ceased from a natural stoppage, but must have been intercepted abruptly, whether by art or by accident, at a time when the level of its course was only sufficiently raised and equalized to make its channel along the valley merely a little wider and deeper in parts than an ordinary Delta channel ; so as even to form in two or three places, considerable pools, not to say lakes, but of no very great depth.

In addition to these considerations, we shall find other reasons to be satisfied that the Etham branch cannot have been naturally extinct in the time of Moses and the older Pharaohs. If we compare the level of the bed of the river at the time of its excision (which is displayed by the section)* with the height of the waters of the Nile at the remote period represented by the map, (which can be estimated with considerable precision), we shall be convinced that it must then have yielded a deep and useful channel, both for navigation and irrigation, along the whole inhabited region of the valley. We must subtract from the height which the Nile now attains during the inundation, the amount added to the river's bed, in the interval, by the annual sedimentary depositions ;—and the nilometer of Roda Island affords a sure index to the height gained by the point of the Delta, from this cause, in a given time. In an average favourable inundation, the water now rises about 35 inches above the 16th cubit of the nilometer, that marked such an inundation—one of 16 cubits—when the column was erected and graduated. This was about A.D. 860.† Thence we may conclude that *about a yard in* 1000 *years* is the amount of rise in the bed and banks of the Nile, by its depositions at Roda Island. For we are not reckoning from a local measurement of the quantity of matter deposited in one given spot in a given time, which is liable to the greatest variations, according as the spot lies high or low with respect to the adjacent lands, and according to the depth of the water ; but we have a natural index susceptible of the strictest accuracy, the actual height of a water line that covers and includes all these possible variations, and that thus gives us a *natural average* far more precise than any one could obtain by computation.

At the rate of a yard of increase in 1000 years, a favourable inundation of the Nile, 3500 years ago, must have been lower by about 3½ yards, with respect to the invariable mean level of the sea, then it is at the present time at the point of the Delta. The slope to the sea being less by so much, the water would be unable to flow farther than *Hero*, except during the season of inundation.

* Section 2,—between Abbasieh and "*Hero.*"

† *Vide* Sir G. Wilkinson's Modern Egypt and Thebes, vol. i., pp. 279–282.

We are thus led by a chain of natural indications to a fact which will enable us to account for the conflicting statements of some ancient authors, relative to the canal that afterwards occupied this valley. For, even after we have made due allowance for the recent accumulations in the narrow gorge of the valley, where the ground rises so strangely, we shall still find that its height above the bottom of the river must have been sufficient to render some amount of *artificial excavation* necessary at the earliest period to which history will permit us to ascend ; otherwise, great injury might have been done by every inundation of the Nile to the habitations and plantations of the early settlers in the valley where so many ruins are found. Although the force of the water, when pressed forward by the rising inundation against this point, would have enabled it at last to excavate a way for itself, the effects of such efforts would be devastation to the neighbouring district, until the hand of man came to the rescue. A very small amount of labour, a mere deepening of the river's annual channel between *Hero* and the point of its rapid descent towards the Crocodile lakes, a space of only six miles, would effectually remove this formidable obstacle to their comfort and prosperity, by keeping the river open all the year round. We cannot reasonably suppose that so necessary as well as easy a work, would have remained undone by the most enterprising and industrious of ancient people, since the tract could hardly be habitable until it was done.

The natural bend of the river, a little beyond the part where its channel might thus have required easing, brought it so near the foot of the low plateau that separates the Crocodile lakes, into which it ran, from the Red Sea, that there are only eight miles distance between that bend and the actual head of the gulf, which, at that time, was near BAAL-ZEPHON (subsequently known as the *Port Daneon*, whose ruins are close to the *Serapeum* of the Antonine itinerary). Since we admit that such a city as BAAL-ZEPHON must have existed on the sea-shore in the time of Moses (which was the golden age of Egyptian history, when its civilization, arts, commercial enterprise, and warlike renown, had reached a point they never afterwards surpassed) we can scarcely doubt that a partial prolongation of the water-course towards BAAL-ZEPHON may have been attempted, even at that early period, to supply the city more easily with water; and that we have thus a natural verification of the accounts transmitted by Pliny and Strabo, who doubtless derived them from some more substantial authority than idle tradition, that the famous canal of the Red Sea was begun by some ancient Pharaoh, whose name is lost to history, and whose deeds have gone to swell the fame of the fabulous "Sesostris." For reasonable inference alone must satisfy us that the safety, prosperity, nay, the very existence, of every city and settlement between "ETHAM" and the sea, depended on that work being so far executed, at an earlier date than systematic historical records can lead us up to. Nature had not only done three-fourths of the work, but she actually compelled man, in self-defence, to execute a considerable portion of the remainder; and what she did not thus actually compel, she suggested, by the physical features of the tract, that were singularly favourable to the execution of this great national undertaking.

On the strength of these various considerations, I had been inclined to favour the conjecture that the direct communication of the channel of ETHAM or *Hero* with the Red Sea, by means of such a short branch canal, might have been effected wholly, at this early period; and that the mouth of this canal, being at the head of the gulf, seemed to explain the etymology of the Scriptural name of the site, PI-HA-'HIROTH, פִּי הַחִירֹת the "*mouth*" or "*opening*" of HIROTH. But the amount to be deducted from the present height of the water-line at the point of the Delta, to give its height at that time—and of which I had not formed a fixed estimate, seems conclusive, that although such a work would be practicable now, it was not possible then for the canal to run into the sea. It is the sea that would have run into the canal. For, if we calculate downwards at the rate above mentioned:—as the highest point now attained by the Nile during the flood season, at Cairo, is only about nine to ten feet above the Red Sea, it must, in the time of Moses, have been nearly level with the sea at the point of the Delta; and, therefore, as much lower, at the termination of the canal, as the difference caused by the downward slope of the lands through which the water had to run.

But the commercial importance of this great undertaking lost nothing material by stopping short of actually piercing through the central natural dyke of the isthmus to which the Delta owes its existence; since that spot is only a low plateau between the hills, five miles or thereabouts in length, and eight feet above the sea in its highest part. A short and easy overland transit like this, over a narrow plain only five miles long from the end of the canal to the sea, could be no serious obstacle to commerce and traffic, when the line of navigation by the river on one side, and by the sea on the other, was wholly uninterrupted.

Nor does etymology require that the canal should run into the sea, to identify this site with the PI-HA-HIROTH of Scripture, near which the Hebrew army encamped "by the sea." For that compound expression would quite as correctly designate any kind of opening or outlet, as that of a stream, natural or artificial. And when we consider the position and configuration of this spot,—that this overland passage is flanked to the right and left by a steep ascent, which forms the table-land, capped with sand-hills, of the originally divided continents of Asia and Africa, we can understand why it was called פִּיהַחִירֹת the "*mouth*" or "opening of Hiroth;"—the pass or gorge in the hills, forming the only opening that leads from the sea to that celebrated ancient city, *viâ* the canal of the same name. It is the very expression employed by Herodotus, when he speaks of the canal being completed by Darius, who cut it across this spot; "and where a mountain *opens* towards the south, it is discharged into the Arabian Gulf." The formidable obstacle presented by the great height of the Red Sea rendered its completion too difficult to be worth running the superfluous risk of the undertaking, while there was such an easy natural road as the "*opening of Hero;*" until another obstruction to commercial traffic was presented, by the gradually increasing height of the great shoal between the upper gulf and the open sea. This necessitated a *second* overland journey across an inhospitable and much longer tract,—for this shoal is 11½ geogr. miles long. So that Darius found it necessary to make the opening for the canal, which his predecessors had not required. The Persepolitan characters found on the fragments of ruins at the north end of this shoal,* testify that his operations were sufficiently important to be recorded on its monuments; and that a marine station existed in his time—if he did not build it—at the very spot where such a station would be absolutely necessary for the accommodation and protection of commercial bands, if, in his time, the sea was no longer navigable at that spot.

As we see no further reason why we should not admit the accounts of Strabo and Pliny, who ascribe the commencement of this great enterprise to a much earlier period than that mentioned by Herodotus, we may now proceed to inquire why such a canal as the latter ascribes to Necho, was required along a valley so well watered by nature and by art scarcely 900 years before, that it is utterly contrary to physical possibility for the river to have failed naturally during that interval.

In proportion as the soil over which the Nile flows is raised by its depositions, the waters of the inundation spread over a greater area of land than before. Such a hollow as the valley of the Etham river presents, must have filled faster than any other channel of the Nile, since little or no alluvial deposits could be borne by the current beyond the acclivity where we have seen that the excavated channel begins. In the time of Necho, a much greater area of land must have been laid under water at every inundation than in the time of the early Pharaohs; and where the course of the Pelusiac branch was so near that of its Etham derivation, its waters were sufficient to irrigate the upper district of the Etham river's course; so that the latter, there, could be dispensed with as useless, while the rest was worse,—very mischievous. For the great height to which the water rose in the valley must have destroyed—instead of fertilizing—the land conti-

* The site of those ruins is indicated on the map, though the name of the place is not known.

guous to the cities that lay all along it; besides causing great inconvenience, by the stoppage of all the roads.*

The causes of this river's disappearance, as well as the era and purpose of such an undertaking, are thus revealed, simply by the make of the land. Necho did not construct his canal because there was *not water enough* in the valley for navigation and irrigation, but because there was *too much!* His object was, on the one hand, to keep up the communication so important to commerce, by means of a water-course, and which, under proper restraint, might fertilize the soil without swamping it; and yet, on the other hand, to reclaim and bring into cultivation a large tract of land lying waste under a mass of equally waste and useless waters.

It is quite clear that such a purpose could not be carried into effect without beginning by draining the valley. The operations of cutting a canal and building up embankments, cannot be carried on in a place which every annual inundation converted into a lake from 12 to 20 feet deep (exclusive of the central channel of the river), for that must have been the amount of the rise in the valley in Necho's time. No one but he who intended to replace the river by such a canal as Necho constructed, would do such a thing as to cut off the only possible supply of water from a chain of the most important frontier cities of Egypt, extending from ETHAM to MIGDOL. It is, therefore, not unreasonable to ascribe to Necho the excision of this part of the ETHAM channel. For it is an inference necessarily arising out of certain facts—the physical fact of the construction of the land, that reveals the expediency of the undertaking—coupled with the historically recorded fact, that Necho made this part of the canal. The conclusion that he cut off the corresponding part of the river, requires no other proof than is afforded by those facts.

A strong embankment thrown across the ETHAM branch at its point of junction with the Pelusiac, would effect this, by

* Mém. sur le Canal des deux Mers. Lepère; Et Mod., vol. xi., p. 83. During the accidental irruption of the waters in 1800, the entire valley, from Abbasieh to Ras el Wady, had the appearance of a sea—the palm trees near Abbasieh were so immersed in water, that only the tops of their leaves were visible.

throwing the course of the waters wholly into the Pelusiac channel. It could easily be done when the Nile was low, for a reference to the section No. 2 will shew that at that season the canal Moëz near Bubastis only has 4 feet of water; and most probably the depth of the Pelusiac, and of its tributary the ETHAM channel, near the same locality, were not more than that of the *Tanitic*, which the canal Moëz replaces.

Under these circumstances, the most convenient point for the new canal to begin would be where the account of Herodotus places it:—"The water was derived from the Nile: it entered it a little above the city Bubastis, near Patumos, the city of Arabia; and it terminated in the Erythrean Sea.*...... They began to sink this canal in that part of Egypt which is nearest to Arabia; contiguous to it is a mountain which stretches towards Memphis, and contains quarries of stone. Commencing at the foot of this, it extends from west to east through a considerable tract of country, and where the mountain opens towards the south, it is discharged into the Arabian Gulf."†

The only portion of this canal that needed excavating was the junction of the Pelusiac near Bubastis, with the valley. The part of the canal that lay along the valley itself, did not even follow the bed of the intercepted river; it must have had the character of a gigantic aqueduct, that entirely confined the waters to the north bank of the valley, and restrained them, during the flood season, to a mere fraction of their original breadth, until they fell into the narrow and high natu-

* *ἦκται δὲ ἀπὸ του Νείλου τὸ ὕδωρ ἐς αὐτήν· ἦκται δὲ κατύπερθε ὀλίγον Βουβάστιος πόλιος, παρὰ Πατούμον τὴν 'Αραβίην πολιν· ἐσέχει δὲ ἐς τὴν Ερυθρὴν θαλασσαν.*—Herodotus; Euterpe, clviii.

† Herodotus further says, that "in the prosecution of this work under Necho, no less than 120,000 Egyptians perished;" but does not say how. The cause of such a catastrophe may however be surmised from the very nature of the operations. We have only to suppose a very probable casualty—that an unusually high inundation of the Nile broke through the newly made embankments, and suddenly overwhelmed the workmen and the works, to see through the truth of a statement which, under the ordinary process of digging a canal, would appear almost fabulous.

ral channel beyond *Hero.* It is in that situation that the ruins of the canal occur, and not in the central depression of the valley where the river originally flowed. The diagram of the canal Moëz, introduced into the section, will give an idea of the height of embankments requisite to convey the waters along the valley without overflowing, even when the Nile rose to its highest point. By a glance at this delineation, in which the true proportions of the parts are given, we see at once the verification of Pliny's account, that the canal was in some parts 30 feet deep. He reckoned from the top of the embankments.

But although Necho replaced the river by a canal, from the Nile to *Hero*, the river remained *in statu quo* beyond that point. The physical indications that such was the state of things remain ; the following remarkable extract from Lepère's " *Mémoire sur le canal des deux mers,*"* will speak for itself. " Les digues du canal sont totalement effacées quelques cents toises après Moukfar ; la vallée devient plus étroite à Saba-Byar,† et l'on doute si le canal a existé dans cette partie, que les sables n'ont pas encore envahie."—P. 73.

Here, from the original elevation of the soil, so remarkable as hardly to admit of the river's passage at all times of the year, without the aid of additional excavation, it is clear that no dykes were ever *necessary*, since the highest inundation possible did not even carry the water out of the bed of the river (or canal) at Moukfar.

Lepère continues thus :—" C'est un peu au delà de ce point que le crue de 1800 présenta un courant extrêmement rapide, (p. 73), * * * courant dont la vîtesse extrême devait résulter d'une pente considérable." (P. 85.)

This is the part beyond which no further artificial excavation was necessary, the water having cut its way through a natural opening in the hill, and afterwards, by a sudden bend to the north-east, making its way into the basin of the Crocodile lakes.§ " L'eau, après avoir fait un grand détour

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* Descr. de l'Egypte, Et Mod., vol. xi.

† *i. e.*, Valley of Seven Wells.

§ At the place where the two sections join, *vide* Pl. V.

à gauche, se répand dans deux vastes bassins qu'elle remplit. Ces bassins ont 6 à 7 lieues de circonférence."*

It is necessary to remark that both the depth of the water along the ETHAM valley, and the height of the acclivity beyond "*Hero*," appear greater in the section of the *present state* of the valley, than they were with respect to the plain of the Delta when the channel was first cut off. And the reason is this :—in all the parts from which the inundations of the Nile have not been purposely excluded, the surface of the soil has continued to rise by the annual deposits of the river ; whereas the general level of the valley from which the free access of the waters has been restrained for more than 24 centuries, has not been raised in any thing like the same proportion. The bottom of the bed of canal Moëz is now from six to eight feet higher than the general surface of the valley, and shews the difference that may be made to obtain the general ground-line along the water-course. The beds of the small canals open to near Abbasieh, are also about 9 feet higher.

Conversely, near Moukfar, where the acclivity appears so exaggerated as to be more like a dyke across a river than a part of its bed, the fact that there was only 5 feet of water, during an *extreme* inundation, in the bed of the old channel that formerly was navigable all the year round, shews that owing to the great accumulations of sand and soil in the hollow of the narrow gorge, during many centuries of neglect, the height of the acclivity must be much greater, in a section that includes all this, than it was when the bed of the river was open.

After allowing for all these circumstances, we still find that the great depth of the valley from ETHAM to *Hero* compared with the other parts of the river's course, must have caused its channel here to be much broader than the other parts, as well as deeper, so as even to form several pools. Besides which there must have been a lake at Ras el Wady, with an island in it, upon which are some unidentified ruins. Another shallower lake may have existed in front of HERO.

* Extrait du Journal de M. Devilliers, Descr. de l'Eg., vol. xviii., App. part i., p. 379–382. *Vide* also the Mém. of M. Dubois-Aymè, ibid., p. 350–351.

The remains of another near ETHAM are still called "Birket el Haj el Kadim," the former Lake of Pilgrims.

In making these allowances for the effects of time between the relative positions of the variable and invariable levels, it may also be as well to remark, that although the present general surface of the same valley may represent the average level of the corresponding parts of the Delta about Bubastis, in the time of Necho, the difference between this average surface at that time, and at the earlier period represented in the map, cannot have been very considerable, because the sedimentary depositions of the river, in a district so constituted, would sink into the deep hollows, and equalize the form of the bottom, rather than elevate its general surface. Hollows which in the time of Moses were deep lakes, may have become the slight depressions we now find them. But, owing to the subsequent elevation of the surfaces of land and water, in the parts which the inundations have been allowed to reach, since their exclusion from this valley twenty-two centuries ago, it has become—relatively to them —so much lower, that if the Nile were now freely readmitted into the valley, it would form a long shallow lake.

As we can now hardly entertain a doubt of the former existence and artificial excision of the ETHAM branch of the Nile, since the main fact that it would still exist, were it not artificially suppressed, stands upon physical proofs that speak for themselves, the secondary task of following it up along its entire course, from the extreme points of its origin and its *embouchure*, will not present any material difficulties ; as of these, satisfactory tokens are by no means wanting.

There is a great dyke connecting the mound of *Onion* with that of *Scenæ*, at "Tel el Jehud." Beyond this point, the water-line, as we before remarked, is intentionally kept down to a very much lower level than is natural, along a series of small and shallow canals of irrigation, one of which is the remains of the canal made by Ptolemy Philadelphus, that fell into Necho's canal at *Thoum* (or ETHAM) near the modern Abbasieh. At this place, the water is now altogether cut off from the remainder of the valley, after having been reduced in height by other intermediate dykes.

We may be sure that where those dykes begin, there the danger to the valley would begin, if the dykes did not exist. Since the great dyke of Tel el Jehud is the first artificial impediment to the free course of the Nile, there the valley of the ETHAM branch must be too low for a free passage of the waters to be safe;—which is as much as to say, there the ETHAM branch parted from the Pelusiac.

The Pelusiac channel, now represented by the canal of Abou-Menedgy, flowed somewhat to the west of the *Onion* mound, and then ran off northwards to Bubastis; while the ETHAM branch bent off to the north-east, skirting the base of the "Arabian Mountain." Here, then, Necho, in order to drain the valley effectually, must have cut off its course through the valley of Belbeis, and confined the course of the Nile exclusively to the Pelusiac arm.

Theory and fact agree to mark this point as the junction of the Pelusiac and Etham branches. For it was a little to the south of the great dyke of Tel el Jehud, and between it and Abou-Zabel, that the water first broke through in 1800, upon the astonished inhabitants of the valley. In some interesting particulars of this irruption, that occur in Mr Devilliers' "*Mém. sur les antiquités de l'Isthme*,"* we find:—"L'eau, s'échappant est d'Abou-Zabel, s'est enfoncée fort avant dans le désert, et est arrivée,—*suivant une direction qu'on ne se rappelait pas lui avoir vu prendre*, auprès de El-Menayr. Le village de Zaoumel a été entièrement tourné par les eaux du canal Abou-Menedgy." (These two places indicated in the section are near the mound "Scenæ.") And in another part, the same observer remarks, that the inhabitants of a village near Abbasieh saw, equally to their consternation and surprise, the water flowing in upon them *both ways*—from Bubastis and from the south.

Thus, the course of the southern half of the ETHAM branch is as clearly manifested by the phenomena attendant on this accidental irruption, as if it still flowed along its forsaken, obliterated, and forgotten channel.

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* Descr. de l'Eg. Ant. vol. v.

The latter part of its course, from the Crocodile lakes to the Mediterranean, is still tolerably well defined; although a great portion of the district through which it flowed has undergone a change of level, from other causes than mechanical deposition, which it is necessary to point out. Though the historical interest of this change is inconsiderable, its geographical and geological interest may warrant a brief reference to the phenomena it has produced, were it only to justify the omission of Lake Menzaleh in a map professing to represent the physical geography of the Egyptian frontier during the remote Mosaic age, and the introduction of water-courses in directions where now, owing to those changes, water could not possibly flow.

The Lake Menzaleh* appears to have been formed by the depression of a considerable tract in the north of the Delta, several feet below its former level, that has taken place since the occupation of Egypt by the Romans, *i. e.*, within the last 1500 years. The waters of the Mediterranean now cover what, in the time of Strabo, was an expanse of marshy plains interspersed with lakes, across which the Mendesian, Tanitic, and Pelusiac arms of the Nile, ran into the sea. The adjoining tract, participating less in the depression, has been converted from cultivated or pasture land, into unhealthy and inaccessible marshes. Ruins of cities, that in the time of the Romans were populous and flourishing, Tanis, Mendes, Thmuis, Heracleus (or Sethrum), Daphne, Pelusium, Silœ, Diospolis-Parva; all these are now found in places accessible only to wild boars and water-fowls; and one city, Tennessus,† formerly described as situated on the Tanitic channel, is now a heap on an island in the middle of the lake.

The natural tendency of the soil of the Delta is to rise by the annual depositions of the river; to drain marshes, by raising their level; and to fill up lakes—not to form and extend them. And this tendency is very sensibly observable on the western coast of the Delta, where it has not been affected by a counteracting downward movement. It is therefore evi-

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* A dotted line in the map shews the present extent of Lake Menzaleh.

† Called also Tennees, or Tenesi. It must be the HANES of Isaiah xxx., 4.

dent that this entire tract must have sunk below its former level since those cities were habitable.

Owing to this depression having cut across the Pelusiac arm, its waters could not follow the old channel up to its mouth, had it remained open. During the flood season, the surplus water still flows along the extinct arm, as far as Fakkoos (*Phacusa*), beyond which it is conveyed under the sand in a direction considerably to the south of the former channel, dividing near Salahieh into two branches that terminate in the marshy lake Ballah, which forms part of Lake Menzaleh at that time of the year.

The waters of the ETHAM branch would also run no further than this lake, were its course to be now restored. It is there that they were lost, in the accidental irruption of 1800. Mr Devilliers, in his journal, says, "Un sheik nous dit: 'Ras el Moyeh el-Ballah a vu l'eau du Nil cette année.'" (vol. xviii., p. 380.) But before any additional depression of that already very low tract had taken place, the centre of the hollow formed by the continuation of the ancient strait northwards, and now occupied by a line of salt marshes and by the above mentioned Lake Ballah, must have marked the bed of the river, as far as MIGDOL, and it may then have passed round the hill of MIGDOL, and run into a lake now dried up and filled with sand, which is the *Lake Serbonis* of Herodotus. During the inundations, a line of sweet water under the sand, apparently the continuation of a deep eastern inlet of Lake Ballah, and along which there are several wells, seems to point out the position of a former water-course extending in the direction of the modern village of Katieh. The firmness of the soil along this line, and abundant vegetation, seem to countenance this supposition. Nevertheless, I must acknowledge that this course of the river beyond MIGDOL rests wholly on inferences drawn from such physical indications as a map esteemed a masterpiece of topographical accuracy in details, affords—for such the great French map of the Delta is admitted to be. The survey of the northern half of the Isthmus did not follow the line of the lowest points. It cut across two considerable swells of ground, at the base of which the water courses lay. A special observation alone can determine whether the above indications are truly vestiges of a former water-course; or whether the termination of its course beyond MIGDOL must be referred to the only possible alternative, that would make it follow the middle of the southern arm of Lake Menzaleh, so as to become reunited to its parent, the Pelusiac channel, about half-way between TAHPANES and SIN or *Pelusium.*

Strabo's account of the entire tract about *Pelusium*, brief as it is, shews clearly that it must have been a very low region, flat, and full of minor hollows, which are now all included in Lake Menzaleh. "Beyond the Tanitic and Pelusiac mouths, there are lakes, and great and continuous marshes, in which are many villages. Pelusium itself is surrounded by marshes and pools, which some call clefts (or pits) (*βαραθρα*)."* That part of Lake Menzaleh is now very shallow, averaging from three to eight feet only.

Such an alteration in the most unimportant part of the Etham river's course, would, however, in no wise affect the main proposition of our geographical theory, that such an eastern frontier channel of the Nile existed, and was naturally open and navigable till two centuries before the time of Herodotus; and would continue so to this day, had it not been kept ever since then, and did it not still remain, suppressed by art.

(*To be continued.*)

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* Strabo, Geog., lib. xvii., § 802.

Edin. New Phil. Jour. Vol. xliv. p. 42.

ARABIAN FRONTIER OF ANCIENT EGYPT

On the Specific Gravity of the Water of the Sea off the Coast of British Guiana. By JOHN DAVY, M.D., F.R.S., Lond. & Ed., Inspector-General of Army Hospitals, &c. Communicated in a letter addressed to Professor Jameson.

MY DEAR SIR,—Conceiving that some useful results might be obtained by determining the specific gravity of sea-water at different distances from the land, along the shores of which large rivers pour out their waters, such as that of British Guiana, on a return voyage which I recently made from that Colony, viz.—in the first week in June,—I had specimens of water taken up for the purposed trial. They were put into phials provided with glass stoppers, and their specific gravity was determined after arrival in Barbadoes in the ordinary way, using a very delicate balance: each specimen was numbered at the time it was obtained.

No. 1 was taken from the shore at George Town, where the Demerara river meets the sea, and where the water is only just perceptibly saline. Its specific gravity at 36° Fahr. compared with rain-water of the same temperature, was 10·036 to 10·000.

No. 2 taken up, where the mail steamer, in which I embarked, was at anchor, about a quarter of a mile from the shore, was of specific gravity, 10·991.

No. 3, from about 11 miles from the shore was of specific gravity, 10·210.

No. 4,	about 19	miles off, was of specific gravity,	10·236
— 5,	— 27	. . . . .	10·2495
— 6,	— 35	. . . . .	10·236
— 7,	— 43	. . . . .	10·2495
— 8,	— 51	. . . . .	10·258
— 2,	— 80	. . . . .	10·266

This last mentioned specific gravity was of water taken up when the sea had acquired, or nearly so, the blue colour of the ocean, and is a near approach to that of sea-water generally in the West Indies. The highest that I have ascertained having been 10·273, which was of water from of the coast of

Antigua, towards the end of an unusually dry season ; the lowest that of 10·260, was of water from near the shore of Barbadoes, taken up after a good deal of rain had fallen during the preceding three months.

With the exception of Nos. 6 and 7, there is a regular and well marked increase of the specific gravity of the water with the increasing distance from the land. In these two instances, it is probable that the slight diminution in the one, and the no augmentation in the other, compared with the preceding No. 5, may have been owing to some heavy showers of rain which fell on that part of the sea, about the time that the steamer was passing.

For practical purposes in navigation, no doubt, it is desirable that more numerous observations should be made on the specific gravity of the water off the coast of British Guiana, and with all possible accuracy as to intervals of distance, position and distance, from the shore. Should it be found, that in all seasons there is a certain and partly regular diminution of the specific gravity of the water in nearing the coast, may not the circumstance be turned to useful account, especially by the mail steamer? Provided with a hydrometer, even in the darkest night, aided by soundings, it is probable the position of the vessel might be determined with accuracy within the range of a very few miles, so as not to be under the necessity of lying to, perhaps sixty miles from land, as is now often the case, and even in nights not particularly dark,—a necessity connected with the lowness of the coast-line of this vast alluvial district, there being on it no conspicuous land-mark, and even the light of the lighthouse in George Town being often obscured by mist.

Reflecting on the subject, it naturally occurs to one, whether the hydrometer might not be useful to navigators, not only in making land where the well-known coast is at all similar to that of British Guiana, as regards rivers and lowness, but also in exploring expeditions off unknown coasts, where the existence of rivers is uncertain, and they are anxiously sought for. In reading the accounts which we hear of the surveys of the coast of New Holland, I have fancied that had a hydrometer been used for ascertaining the specific gravity of the water, where the proximity of the river has been conjectured and laboriously sought for, the enterprising navigators would have had a great aid in solving the problem. It may be said, that the coast of British Guiana is almost peculiar, on account of the many and large rivers by which it is broken. This is true; and, the diminution of the specific gravity of the water of the sea there is, in proportion, remarkable. Where fewer and smaller rivers have their outlet, there a less diminution, but some diminution, may be expected to be found on approaching land, appreciable by the hydrometer and an indication of the circumstance,—the difference being only in degree.

In conclusion, I may remark, that the sea for many miles off the coast of British Guiana is more or less discoloured; near the land it is the colour of the Thames at London bridge,—light brown. This, with increasing distance from the shore, acquires a greenish hue; the pure blue of the ocean is hardly observable within eighty miles of the land. In all the specimens of sea-water which I had taken up, with the exceptions of Nos. 8 and 9, there was, on rest, a minute sediment (the cause chiefly of the discoloration), diminishing with the distance at which each was collected. Observed under the microscope, this sediment, in each instance, appeared to consist of granular matter, the granules commonly less than $\frac{1}{2000}$ inch in diameter, and of minute laminæ of irregular form, seldom exceeding $\frac{1}{4000}$ inch in diameter. The exceeding firmness of this discolouring matter is not surprising, when it is considered that the rivers which are the carriers of it, flow for many miles with a very sluggish course; and that the bottoms of many of them, perhaps of all of them, in part, are actually below the level of the sea. The discolouring material is, no doubt, chiefly earthy matter, and probably mixed with very minute portions of vegetable and animal matter: this seems to be indicated by the granules being collected together in little masses. Resting on the sediment in the specimen of water taken up close to the shore, was a mucor-like substance. And, it may be, that to the presence of a portion of animal and vegetable matter, the alluvial soil of British Guiana, so productive without manure, in part owes its fertility, as well as in part to the extreme minuteness of division of the inorganic earthy portion, its principal constituent. Believe me, my dear Sir, very faithfully yours,

J. Davy.

Barbadoes, *August* 15, 1847.

On the Urinary Secretion of certain Animals, considered in connection with their Temperature, Food, &c. By John Davy, M.D., F.R.S. Lond. & Ed., &c.

1. It is well known that the urinary secretion in the instance of many birds,—animals exceeding all others in temperature,—consists chiefly of lithate of ammonia. So far as my inquiries have extended, I have not met with a single exception ; even in the case of birds, as the parrot and the dove, living in confinement, restricted to a diet entirely vegetable, I have found it the same. The dove, in the particular instance to which I allude, was fed on Guinea and Indian corn, the parrot on bread and fruit, chiefly the plantain ; and other parrots of several kinds, the urine of which I examined in Ceylon many years ago, and was found similar, were fed chiefly on rice and plantains.

2. Insects, with a variable temperature, varying, it would appear, with the degree of their excitement, or energy of action, or of respiration, whether living on vegetable or animal matter, or on a mixture of the two, have, according to my experience, a urinary secretion like that of birds, composed chiefly of lithate of ammonia and lithic acid.

3. Spiders, of low temperature, but of considerable activity, living entirely on insects, secrete a urine of a different kind, being composed, as I have found it, of xanthic oxide.

4. Serpents, of low temperature, a few degrees only above that of the atmosphere in which they live, occasionally, like the spiders, making great muscular exertions, and, like them, capable of living a long time without food, and their food being entirely animal, have their urinary secretion composed chiefly of lithate of ammonia.

5. Lizards, with a temperature like that of serpents, and, like them, living entirely on animal matter, resemble them also, so far as my experience allows me to speak, in the composition and quality of their urine. The trials I have made of it have been limited to that of three or four different species.

6. The frog and toad, both of very low temperature, living entirely on animal matter, and capable of long continued fasts, have a urinary secretion different from that of any of the preceding. In all the preceding instances, this secretion would appear to pass from the secerning organs,—the kidneys, —in a semifluid state (granules of lithate of ammonia, mixed with a little watery fluid), and to become solid before it is voided, or shortly after, in consequence of the absorption of the aqueous part in the cloaca serving as a urinary receptacle, or its loss by evaporation in the open air. But, in the instance of these Batrachian animals, it is secreted by the kidneys, in a liquid state, and very dilute, and is commonly, after passing into the cloaca, received into a very thin, and dilatable, and contractile bladder, which communicates by a large longitudinal opening, provided with a valve,* with the lower part of the intestinal canal,—the cloaca,—in which the waters terminate.† The dilute liquid urine of these animals consists chiefly of water holding, in solution, urea and a little saline matter, and, in its composition, may be considered as an approach to the human urinary secretion. Many years

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* I am not aware that the valvular structure alluded to above has yet been described; it is a semiluna fold of the delicate lining membrane of the cloaca, extending across, not unlike the valve of a vein in its form, and, in position, in regard to the opening into the bladder, not unlike that of epiglottis in relation to the glottis. When pressed down, as by the pressure of a probe moved towards the anal opening, it completely covers the aperture into the bladder. It is perfectly well adapted to allow a fluid, descending from the waters, to pass when the sphincter ani is closed, and to prevent fœcal matter from entering the bladder in its descent through the cloaca, where it never lodges, a sphincter above keeping it in the large intestine.

† As difference of opinion exists amongst high authorities in comparative anatomy relative to the termination of the waters of these animals, I may mention that I have passed a fine leaden probe through the water of the toad into its cloaca.

ago, I found this to be the nature of the urine of a large species of frog, and of a toad which I examined in Ceylon.* Lately, I have found the urine of the toad of this island (Barbadoes), which is of the same species as the common toad of Europe (*Rana bufo*), of like composition.

What are the bearings of these facts in their physiological relations? Do they not prove that neither the temperature of the animal, nor its activity, nor even its food (that is, the physiological conditions connected with respiration, muscular action, digestion, &c.), affect, materially, the nature, as to composition, of the urinary secretion? And does it not follow that the quality of this secretion, therefore, must depend chiefly on the intimate structure of the secerning organs? This is a view which, for a long while, has appeared to me most consistent with established facts; though, I believe, it has never been generally adopted, and, recently, other views have been taken, theoretically very different, which have been supported by much ingenuity of reasoning, but not, I apprehend, equally by facts.

I have spoken of the toad and frog as having a urinary bladder. The function of the organ I allude to, and its proper denomination, have, for a long while, been a subject of difference of opinion; some inquirers holding it to be a receptacle for urine, others, the receptacle of a fluid not derived from the kidneys, but rather the product of cutaneous absorption. Even recently, I find that two English physiologists maintain this latter opinion; one of them seems to ground it chiefly on the anatomical argument, that the vesicle, the bladder of these animals, is the "unobliterated remains of the allantois of the embryo."† Granted that it is so, if it be found to have increased in size with the growth of the animal, and to be so modified as to answer the purpose of a urinary bladder, fitted to receive this fluid, and to let it escape when necessary, and that the fluid which is found in it is actually of the nature of urine, as regards chemical com-

* The results will be found in a paper published in the Philosophical Transactions for, I believe, 1817, and in the first volume of my Researches.

† Professor Rymer Jones, in his "General Outlines of the Animal Kingdom,' p. 535. London, 1841.

position, must it not be considered, having the functions of a urinary bladder, to be such in reality? Moreover, apart from the chemical composition of the fluid, it appears to me difficult to conceive how, on the supposition of absorption (the ground on which the other physiologist supports his opinion),* it can find its way into the bladder, inasmuch as this organ is provided with few bloodvessels from which an inhalation can take place; nor does it appear to possess the property of imbibition or endosmosis, by which fluid could be drawn into it from the cavity of the abdomen; for when immersed in water, empty and collapsed *in situ*, immediately after the decapitation of the animal, it does not become distended.

Before concluding, I would make one remark, which is, that though I believe the quality of the secretion of the kidneys to depend chiefly on structure, I am also of opinion that this secretion is affected, in a minor degree, by circumstances of diet, and of atmospheric temperature, and especially in man. In a cold or cool climate, using a diet chiefly of animal food, lithic acid and lithate of ammonia are found commonly, in a vegetable proportion, in the human urine; but not so in a hot climate, not even when the diet is the same; and, in consequence, within the tropics, where least oxygen is consumed in respiration, the ailments depending on the formation of gravel and calculi are almost unknown. In the instances of other animals, no doubt, the proportion of the urinary matter, the quantity secreted, depends very much on the quantity of food taken; and, when, as in some instances, it is a mixture of animal and vegetable matter, and the urine secreted is semifluid or concrete highly azotised matter, as in some birds or insects, it depends also on the quantity of the former that is consumed.

BARBADOES, *September* 6, 1847.

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* Professor Bell, in article *Amphibia*, Cyclopædia of Anatomy and Physiology, p. 104.

Observations on the Petrifaction of Shells in the Mediterranean. By MM. Marcel de Serres and L. Figuier.

All the researches of modern geology seem to prove that nothing is changed in the order of nature, and that the same causes which operated in the first ages of the world, are still influencing the occurrences that take place under our own eyes. Certain facts, however, have hitherto appeared not to be referable to this common origin; and the petrifaction of organic remains, in the midst of geological formations, is daily adduced as one of the most weighty arguments against this general law.

Few persons, indeed, will be ready to admit what, however, is an indisputable fact, that there are now forming, in the bosom of seas, petrifactions which, in the double respect of chemical composition and mode of petrifaction, are altogether analogous to those which are formed in the bed of the ancient sea. The object of this memoir is to demonstrate this general fact, and to study the phenomena by means of which it is brought about.

We hope to prove, at the same time, that the sandstones containing the molluscous remains which cover, as is well known, spaces of such vast extent in the tertiary formations, have their analogues in the shelly rocks of recent formation, which are formed, in our own day, in the middle of the Mediterranean.

I. *On the Mode in which Organic Bodies became Petrified in Historical and Geological Eras.*

If we reason according to the facts which occur in our own day, certain conditions seem necessary to produce the petrifaction of organised bodies, or, in other words, these petrifactions are not observed but where these conditions are united. We may admit, without deviating too much from probability, that the same circumstances were necessary to produce this phenomenon during the geological epochs.

In order that organic remains may become petrified, that is to say, in order that the organic matter they contain may be replaced by a mineral substance which preserves their forms and most delicate lineaments, it is necessary, in our opinion, 1*st*, that these remains should be sunk in great masses of water; 2*dly*, that the waters should contain, in certain abundance, calcareous or siliceous salts.

It is easy to conceive, that the first of these conditions must have been constantly present during geological times, as well in respect to the organised species deposited in seas, as in regard to those existing in fresh waters. To be convinced of this, it is sufficient to compare the extent occupied by seas at periods when there was no human witness, with that which they now occupy.

In fact, the waters which filled the basin of the seas of geological times, not only occupied very large spaces, but they also possessed a more energetic dissolving property, if we may judge from the great quantity of substances which they have deposited on the surface of formations. A similar comparison between the fresh waters of the old world, and those which now fill the lakes and lowest points of continents, will lead to the same conclusion. Indeed, it does not appear that existing fresh waters can produce such considerable deposits as those which have been left by the rivers and lakes of the old world.

The important part which carbonate of lime and silex have performed in the phenomenon of petrifaction, appears from a simple examination of facts. The greater part of geological petrifactions have been produced by means of carbonate of lime. This phenomenon is always more complete when the waters among which it takes place contain this salt in abundance. When the gypseous formations contain organic remains, which rarely happens in regard to the mollusca, they are found to be in a state of incomplete petrifaction, as may readily be seen by examining the bones found in such places. It is the same with the most part of the arenaceous formations and deposits of clay, where the shells preserve their distinct appearance as well as in the gypseous formations. It is, in fact, among marls and sands that the remains of the life of geological times are best preserved and most frequently found.

After the carbonate of lime, silex is the most frequent agent of petrifaction; it is superior even to the carbonate of lime in the fidelity and delicacy with which it reproduces the finest lineaments of organic remains.

Besides, certain peculiarities of these organized bodies appear to have been not without influence on the siliceous pseudo-morphoses. Thus, the parts of bodies of sufficient consistency to preserve their form during the time necessary for petrifaction, are almost always in the calcareous state, and those of less consistency have passed into the siliceous state. We often see the ligaments of Grypheæ changed into silex, although the head be petrified with calcareous matter. The greater part of the fossil Alcyons and Sponges are almost always transformed into silex. In like manner, the nuclei of these shells are more frequently metamorphosed into silex than their heads. The Ananchites and the other Echinides of the green sandstone, whose head is almost always calcareous, have a siliceous nucleus in the interior, which often fills the whole space. One would say, that the animal matter has sometimes issued from it as if squeezed out by mechanical pressure. Finally, the siliceous zoophytes are often found disseminated throughout calcareous rocks, which seems to indicate a kind of electrive attraction of the animal matter for silex.

Carbonate of lime and silex are not the only substances which have concurred in the petrifaction of the organized bodies of the old world. The peroxide of iron, anhydrous or hydrated, and the sulphur of iron have co-operated. Indeed Ammonites are sometimes transformed into Oligiste or Limonite. Many of these Ammonites, partly ferruginous, are not less calcareous, like the formations in which they are found; often they are even converted into pyrites.

To this explanation of the petrifaction of the remains of organized bodies, by means of previous dissolution, it will perhaps be objected that the carbonate of lime and silex, which are the most ordinary agents in producing this phenomenon, are naturally insoluble in water. But we know that the carbonate of lime dissolves in an excess of carbonic acid, particularly when aided by an increase of pressure, and the bicarbonate of lime is met with in sea-water in considerable proportion. With regard to silex, the action of alkalies, the elevation of temperature, the gelatinous or nascent state induce its dissolution, as is well known. The solubility which it acquires in these circumstances may be conceived to admit of the formation of the zeolithes and amygdaloids, which we so frequently meet with in the neighbourhood of igneous rocks. Finally, in certain circumstances, the silex is taken away from the rocks that contain it by the heat of the water alone. It is to an effect of this nature that we must refer the origin of these siliceous deposits, found in such great quantities in Iceland, at the bottom of the Geysers. M. Dumas admits that, in these particular cases, the silex is dissolved by the repeated shock of the steam escaping from the warm springs. The thermal springs of that country, indeed, contain a considerable quantity of silex in a state of dissolution, caused by the double effect of heat and alkalies.

An increase of pressure is not perhaps without influence on the solubility of this earth. We are tempted to believe this, on witnessing silex existing in a state of solution in the greater part of subterranean waters, such as the mineral springs applied to medical purposes. Lastly, when we remark that a great number of vegetables contain notable quantities of silex in their stalks, and in certain of their members, and when we find silex in a dissolved state in the waters of many rivers, we are led to believe that the greater part of fresh waters contain small quantities of this substance.

If we decline to admit the fact of a real dissolution of silex in the waters which have petrified shells in geological times, it will be sufficient, for the explanation of the phenomenon, that we admit its gelatinous state. If it be necessary that silex should be in a state of dissolution before it can produce rock-crystal, it is evident that, by solidifying to the gelatinous state, it has produced the silices, and particularly the agates and calcedonies.

The preceding observations authorise us, therefore, to refer the phenomenon of the petrifaction of organic remains, during the geological and historical epochs, to a mineral substitution brought about by means of *substances dissolved in waters, where they are found in a gelatinous state.*

II. *Facts which prove that Petrifactions are now forming in the bosom of existing seas, analogous to those of Geological times.*

The shells in the bottom of the Mediterranean, abandoned by the animals which formed them, there meet with the conditions indicated above as indispensable to their petrifaction. They are sunk in considerable masses of water, holding notable quantities of carbonate of lime in solution. Accordingly, to the calcareous carbonate which composed the shell in a fresh state, a new quantity may be added or substituted, furnished by the waters of the sea, and which replaces the animal matter, and the carbonate of the original lime. This is just what we observe, and in different degrees, according as the petrifaction is more or less advanced. We shall afterwards study, with the necessary details, the whole of the different degrees of this phenomenon. Let us now confine ourselves to the simple announcement of the fact, which we shall immediately examine in such a way as to remove all doubts.

But it is not on our own coasts only that we find shells brought to a state of petrifaction in our own era; we have received from Algiers masses of shells transformed into a crystalline limestone of a peculiar whiteness and brilliancy, similar to alabaster. We find in these shell-rocks, as they may be called, small rolled pebbles, encrusted with a stalagmitic and crystalline coating. This same coating appears to be the cement which has agglutinated the rolled pebbles; the latter are siliceous or calcareous. Among the shells composing these masses, we notice only genera and species of our own epoch, particularly Pectunculus and Cardium; more rarely univalves. The officers who have brought us these shell petrifactions from the neighbourhood of Algiers, assure us that they are formed in our own times, and in the historical epoch. But as we have not ourselves observed these masses of shells in the places where they occur, we cannot very positively assert that such is really their origin.

We may add, that it is not shells alone which may be thus brought to the state of petrifaction in the midst of salt waters. It is easy to produce examples of vegetable petrifactions formed in recent times. We may first refer to the curious observation of M. Lyell. This geologist found grains of chara petrifying, in the present day, into calcareous matter in the lakes of Scotland, just as seeds of the same vegetable petrified into calcareous matter in the lacustrine waters of the old world. Captain Baux observed a fact of the same kind in the island of Mogador. Stalks of fucus, belonging to the same species as those living in the surrounding sea, have become, as it were, centres of attraction for the calcareous and siliceous salts. These substances have precipitated themselves on the stalks, around which they are moulded. Some of these stalks, as yet incompletely petrified, shew some traces of vegetable tissue. M. Baux could compare them with the fuci of the neighbouring sea, and he found that the petrified fuci were identical with *Fucus natans*.

M. Blast, of Bombay,* has discovered, in the neighbourhood of Cairo, an entire forest converted into silex ; the vessels, medullary rays, and even the most slender fibres, are distinctly visible. The petrified trees are from 16 to 18 metres in length. This phenomenon extends over a surface of many hundred miles. The whole desert which is crossed by the road from Cairo to Suez is strewed with these trees, which seem to have been petrified on the spot, and in the existing era. At least this forest is covered by nothing more than sand and gravels. The latter, and the trees embedded in them, rest on calcareous limestones, which contain oysters with their texture and colour so little altered, that one would believe that they had been but recently left by the waters of the sea. It is therefore probable that these substances belong to our own era ; and we may adduce this interesting fact as tending to prove the transformation of living shells into new calcareous carbonate.†

We may add, in the last place, that the waters of the sea are not the only ones which can cause the petrifaction of shells in the existing period. In India, in the territory of Kurneel, there is a thermal spring which forms abundant calcareous deposits, and in which numerous fresh water shells of the genera Melania and Planorbis are found. These shells, in different states of petrifaction, are sometimes entirely converted into calcareous spar, while others preserve only their interior mould ; and, lastly, there are some of them covered with quartz crystals, while in others these crystallizations are in a rudimentary state. The shell deposites formed by the thermal spring of Kurneel, have a consistency analogous to that of the siliceous tufas of the warm springs of the Geysers in Iceland. The transformation of the shells of living Melania and Planorbis into siliceous matter is a much more surprising fact than the conversion of the shells of the Mediterranean into calcareous matter different from that of which they were primitively constituted.

The facts which we have passed in review sufficiently demonstrate, in our opinion, the reality of the phenomenon of the petrifaction of shells in the present day, and impart to it besides a remarkably general character. We must now examine the phenomenon more closely, by following the progress, and pointing out the differences which present themselves according to the diversity of the species.

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* L'Institut, April 1846, p. 116.

† Along with these facts, which we are unable to give on our own authority, we may add the two following, which are of great value in reference to the question now before us :—

The *Cardium edule*, in a petrified state, is said to form considerable banks at the mouth of the Sommé.

At Caucale, oyster-shells, which have been thrown into the sea after having appeared at table, there become petrified like our shells in the Mediterranean. If this statement be correct, it is evident that it meets all objections.

III. *On the progress and different degrees of the Petrifaction of Shells.*

The indispensable condition for shells becoming petrified in our epoch is, that they remain for a very long period submerged in the sea. When merely left on the shore they exfoliate and become disintegrated, but never petrify. The whole is then reduced by a slow but total destruction, the rapidity of which depends on the external circumstances to which they are subjected. But the process is very different with those which remain sunk in the water.

The shells abandoned by the animals which inhabit them, and principally such as are left near the shore, are for a long time tossed about by the waves. The first modification they undergo is in the alteration of their colours. Thus discoloured, they are often thrown out on the beach, where they are found in great plenty after rough weather and violent winds. The loss of their natural colours is the first effect produced on the shells and the solid and calcareous tubes of the Annelides, then on the stony masses of the Polypi; the second, and the more considerable, consists of the alteration of their substance. This alteration first appears most evidently on the shells provided with angles and elevated ridges. The grooves and prominent parts disappear, and the surface becomes uniform. This is particularly observable in the large ribbed Buccini, such as *Cardium album*, *trebberea*, *tuberculatum*, and *aculeatum*. The prominent ribs, and the osseous interstices, which are so conspicuous in the fresh shells, scarcely leave sensible traces of their existence when the alteration is somewhat advanced. This first modification is particularly obvious in the Pectunculi, in which it often exposes their singular structure beneath the external covering. The Citheræ likewise lose their external coat, and exhibit the structure of their interior layer.

In proportion as these modifications advance, sand is precipitated into the interior of the valves of the shell-bearing Molluscs, where it becomes agglutinated and hardened, occasionally enclosing more or less considerable remains of small shells in the interior of their masses. The calcareous matter which, by the effect of this mineral substitution, is precipitated into the very substance of the shells, often becomes there a kind of sphere of attraction for salts of every kind existing in a state of solution in the sea-water; in consequence of this attraction, the carbonate of lime is precipitated on the exterior surface, as well as on the interior of the shells, and there forms a crystallization often well-marked, and sometimes of considerable regularity. The form of these crystals is referable, for the most part, to the inverse variety of Haüy.

We have collected a considerable number of shells, in which the original substance has almost wholly disappeared, and is replaced by a carbonate of crystalline lime, the aspect, colour, and transparency of which have no relation to that which at first composed the shell. The difference is so great, that if the carbonate of crystalline lime had not preserved the general form of the shell, it would be impossible to recognise the origin of their new bodies. We have also found a Triton, the *modiferum* of Lamarck, which presented singular circumstances. All the inequalities found on the surface in a fresh state have completely disappeared, and it has become quite smooth; it is wholly transformed into a crystalline limestone. One of its sides has lost a part of its substance; and this opening seems to have served as a passage to the lapideous liquids which have penetrated into the interior of its cavity, and by accumulating there, have given it a very great density and hardness. We likewise possess a curious specimen of a mass of shells petrified and agglutinated together, found in the neighbourhood of Algiers. We can distinguish among these shells, *Murex tranaclus* and *arentinus*, *Natica cruentata*, *Venus verrucosa* and *gassina*, *Cardium tuberculatum* and *eduli*, *Pecten glaber*, and *Pectunculus glycimeris*. We likewise notice a *Lucina*, not sufficiently entire to be determined; and, lastly, a cast resembling *Mytilus afer*, which is known to live on the coasts of Barbary. Among the most remarkable individuals of the last mentioned localities, and which, like these just spoken of, have been transformed into crystalline alabaster, we may mention particularly a *Triton modiferum* of large size; it is almost double the dimensions of those belonging to our coasts; numerous inverse crystals of carbonate of lime are deposited in its interior. We likewise possess another fragment about 40 square centimeters, composed almost entirely of the agglutinated valves of Petcunculi, which are likewise transformed into crystalline alabaster. The valves are soldered to each other by a gluten of the same nature, the whole as solid and brilliant as that composing the valves themselves. This specimen, the origin of which is unknown to us, appears, however, to come from our own coasts, for it existed in the collection of the Faculty of Sciences, long before we had formed settlements in Algiers.

All the shells in the bosom of seas do not undergo the same kind of alterations. For the most part, Oysters and Pectens receive the lapidific fluids only between the leaves of their laminæ, which renders them more solid and stony than in their fresh state. Often the species of this genus not having very thick valves, such, for example, as *Ostrea cristata*, are impregnated with a calcareous gluten, which solders the valves together, in the same manner that takes place in a great number of fossil species, particularly those of the secondary formations. Sometimes the stony valves of large oysters, particularly those of *Ostrea edulis* in the Mediterranean, are covered on the outside with crystals of the carbonate of lime. When this quantity is considerable, it renders these oysters as dense as those of geological times. The superior valves of the Pectens, are likewise covered with small calcareous or sandy deposits; but the latter are never abundant, the valves of these shells not being of sufficient thickness.

When the petrifaction has reached its last stage, the carbonate of lime which composed the shell in its fresh state, has totally disappeared. It has been replaced, pretty generally, by a crystalline calcareous substance, which retains, more or less, the form and structure of the shell in which it was formed. We pretty often see shells metamorphosed in this manner into new limestone, encrusted with a layer of sand, more or less thick, and always indurated.

All kinds of shells do not appear susceptible of petrifying in the same degree; we have hitherto observed very few species of the genus Venus in this state. A certain number, however, are to be found in the Mediterranean, among which we may mention, as the most common, *Venus decussata*, *virginea*, *rugosa* and *galinea*. This circumstance is so much the more remarkable, as this genus is extremely frequent in the tertiary formations, where it is petrified, like the greater number of the species of this formation. The same thing may be observed of the small Tellinæ, so numerous in the Mediterranean, and which, notwithstanding, are very rarely petrified.*

There is, lastly, another kind of alteration presented by shells, and of which we shall only say a few words, because it is not connected very directly with the question under discussion; and which, moreover, takes place among fresh as well as petrified shells. When shells, or rocks containing shells, remain a long time in the mud or in puddles of brackish water, such as are very often found along the shores of the Mediterranean, they become of a black or deep blue colour, more or less intense. This change in the colour does not extend much further than the exterior surface. To be convinced of this, we have only to break an oyster, or some other shell thus darkened, when we perceive that the shade of colour does not go beyond a few millimetres beneath the surface; the rest of the shell presents the white colour of carbonate of lime. This alteration is owing to the sulphur of iron, which is formed at the expense of the oxide of iron, forming part of the shell, and the sulphuretted hydrogen spon-

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* We believe that the facts contained in this chapter, afford a sufficient answer to an objection which has been made to us by some geologists, and which we shall now state. It is alleged that the petrified shells found on the shores of the Mediterranean may come from geological formations; the waves may have detached these shells from the tertiary formations, in places where these formations formed the bottom of the sea, and they may have been thrown up on the bank. The two following remarks are sufficient to destroy this argument:—

1. We find, in the Mediterranean, shells in every stage of petrifaction, from simple discoloration to their complete transformation into carbonate of crystalline lime.

2. The molecular structure of the petrified shells of the present day is often very different from the structure of fossil shells. The former most frequently have a crystalline texture; the latter are always in a compact state.

Besides, the facts which we shall afterwards mention, in reference to the modern shelly sandstone now produced in the Mediterranean, do not leave us any room to doubt the reality of the important phenomenon we are illustrating in this memoir.

taneously disengaged from the mud in the midst of which the shells are lying. Indeed, if we scrape the black part of the shells, and treat them with diluted chlorhydric acid, suspending a paper saturated with acetate of lead in the phial in which the gas is disengaged, the paper blackens in a few instants.

IV. *On the Chemical Composition of Shells, considered in a fresh and also in a petrified state, during Historical and Geological times.*

It is necessary, in order to complete the preceding observations, to submit the shells petrified during the two great epochs in the history of the earth, to a chemical examination.

In order to render the results at which we arrive comparable, we must examine the same species found petrified in geological formations and in our own seas, for it would be illogical to compare, in respect to chemical composition, a Belemnite or an Ammonite, for example, with a Mactra, a Buccinum, or any other genus of a modern formation. Among the genera petrified in present times, we have chosen particularly those found most frequently in that state, that is to say, Oysters, Pectunculi, and Buccinum. Finally, as none of these shells, with the exception of Ostrea, from the ocean, have hitherto been subjected to analysis, we have thought it right to analyse chemically all these species taken in a fresh state.

The following are some of the processes followed in these anslyses. The animal matter has been determined in the following manner: 10 grammes of the shell were taken, reduced to powder, and deprived of the water it contained by prolonged exposure to a heat of about 150 degrees, till the weight of the matter ceased to undergo any change. These 10 grammes of matter, perfectly free from water, were then calcined to a red heat in a porcelain crucible, in order to destroy the organic matter. As the read heat had necessarily decomposed a part of the carbonate of lime of the shell, the calcined matter was then moistened with a concentrated solution of carbonate of ammonia ; a heat, below a red heat, was then carefully applied, in order to recompose the carbonate of lime destroyed, at the expense of the carbonate of ammonia. On again weighing the matter after this treatment, the loss undergone by the 10 grammes of matter employed, represented the organic matter destroyed. We have attempted to determine the animal matter by another process, for the difficulty of drying the shell thoroughly, without altering the animal matter, may leave some doubt. The shell, dried only by a heat of 100 degrees, has been dissolved in hydrochloric acid, the precaution being taken to add this acid in small portions, in order to prevent the liquor becoming heated. The shell dissolved, leaving only the insoluble animal matter under the form of filaments or delicate membranes, just in the same manner as when bones are treated with hydrochloric acid in order to extract the gelatine.

By operating in this manner, we have always obtained a smaller quantity of animal matter than by calcination; probably because a part of the organic matter was dissolved in the chlorhydrid acid. We know, indeed, that in the dissolution of the gelatine of bones by acids, it is impossible to prevent the dissolution of a small quantity of the organic substance. This method, however, served to check the results of the first method, and to shew that the relative numbers obtained by the two methods followed in the experiments were the same. We may observe, however, that the last mentioned process could not always be followed in regard to shells recently petrified. These often retain a little sand between their laminæ, of which it is impossible to deprive them. After the action of the acid, this sand remains mingled with the animal matter, which, besides, is in very small proportions.*

The phosphate of lime has been treated by evaporating the solution of shells in chlorhydric acid nearly to dryness, again taking it up in water, evaporating it anew, and slightly calcining the residuum. Taken up with water, the latter leaves a mixture of phosphate and sulphate of lime. As the sulphate of lime would have required too many washings to be freed from the phosphate of lime, the mixture was weighed, dissolved in chlorhydric acid, and the sulphuric acid precipitated by a salt of barytes. The weight of the sulphate of barytes indicated the quantity of the sulphate of lime, and the difference between the weight of the sulphate of lime from that of the primitive mixture, indicated the quantity of the phosphate of lime.

The other constituent principles of shells have been determined by the ordinary means, agitating the solution in chlorhydric acid.

Table of Analyses of Living Shells, and of such as have been petrified in Geological and Historical eras.

OYSTERS.			
	1. *Ostrea edulis.* 2. Varieties C. of Lamarck, living in the Mediterranean.	*Ostrea edulis.* Var. C, petrified in the Mediterranean.	*Ostrea*, nearly related to *Ostrea hippopus* of the superior marine tertiary formations (Pliocene.)
Animal Matters,	3·9	1·5	0·8
Carbonate of Lime,	93·9	96·3	96·5
Carbonate of Magnesia,	0·3	0·1	1·4
Sulphate of Lime,	1·4	0·7	0·5
Phosphate of Lime,	0·5	...	...
Oxide of Iron,	(traces)	1·4	0·8
	100·0	100·0	100·0

* The animal matter obtained from shells is azoted, and presents the character of coagulated albumen.

PECTENS.

	Pecten glaber, living in the Mediterranean.	*Pecten glaber*, petrified in the Mediterranean.	*Pecten* of the superior marine tertiary formations (Pliocene.)
Animal Matters, . .	3·0	0·9	0·7
Carbonate of Lime, .	96·0	97·3	96·7
Carbonate of Magnesia,	(traces)	0·8	0·4
Sulphate of Lime, . .	0·7	0·5	0·8
Phosphate of Lime, .	0·3	...	...
Oxide of Iron, . .	(traces)	0·5	1·4
	100·0	100·0	100·0

VENUS.

	Venus virginea, living in the Mediterranean.	*Venus virginea*, petrified in the Mediterranean.	*Venus semilis*, of the superior marine tertiary formations (Brochi.)
Animal Matters, . .	3·0	0·6	1·0
Carbonate of Lime, .	96·6	99·2	97·9
Carbonate of Magnesia,	(traces)	...	...
Sulphate of Lime, . .	0·3	0·2	0·6
Phosphate of Lime, .	0.1	...	...
Oxide of Iron, . .	(traces)	...	0·5
	100·0	100·0	100 0

PECTUNCULI.

	Pect. glycimeris and *flamulatus*, living in the Mediterranean.	*Pect. glycimeris* and *flamulatus*, petrified in the Mediterranean.	*Pectunculus pulvinatus* of the superior marine tertiary formations
Animal Matters, . .	2·4	0·7	0·8
Carbonate of Lime, .	97·2	99·0	98·4
Carbonate of Magnesia,	(traces)	...	...
Sulphate of Lime, . .	0·4	0·3	0·4
Oxide of Iron, . .	(traces)	...	0·4
	100·0	100·0	100·0

CARDIUMS.

	Cardium tuberculatum, living in the Mediterranean.	*C. tuberculatum*, petrified in the Mediterranean.	*Cardium* of the superior marine tertiary formations.
Animal Matters, . .	2·0	0·8	0·5
Carbonate of Lime, .	97·8	98·7	98·8
Carbonate of Magnesia,	(traces)	(traces)	0·1
Sulphate of Lime, . .	0·2	0·5	0·3
Oxide of Iron, . .	(traces)	(traces)	0·3
	100·0	100·0	100·0

The result of these analyses sufficiently shews the remarkable resemblance that prevails, in respect to their composition, between the shells petrified in geological times, and those petrifying in the Mediterranean. The small quantity of animal matter contained in both is pretty nearly the same; shells recently petrified offer only a slight excess over fossil species, which, however, is never considerable.

The phosphate of lime existing in certain of these shells in a living state, such as the Oysters, Pectens, and Venus, is not found in petrified shells, whatever be their date. This peculiarity perfectly accords with the geological observations mentioned above.

It will be remarked, finally, that all the shells examined contain sulphate of lime. Although this salt is found in pretty considerable proportion, it had not been indicated in the analyses of oysters, as given by Vauquelin, Bucholz, and Brandex. The existence of this earthy salt cannot, however, be doubted; for if we calcine the shells of Oysters, Pectens, and Venus, and dissolve the residue of this calcination in chlorhydric acid, the liquor will discharge sulphuretted hydrogen in abundance.

Of the Shelly Sandstones now forming in the Mediterranean.

We ought, in conclusion, to direct attention to those shelly sandstones, which we observe in our own day on the shores of the Mediterranean, and which we have already referred to as representing the analogues of the shelly sandstones met with in such abundance in geological formations, particularly of the tertiary epoch.

It often happens that the sands of the Mediterranean, when they become cemented together, incorporate in their masses a great number of shells in a more or less advanced state of petrifaction, and thus form true banks of shells. These modern shelly sandstones differ from the shelly sandstones peculiar to the geological formations only in their small extent. They are found disseminated in the midst of sea-sands, forming scattered insulated blocks, without continuity, and at very unequal distances.

It has appeared to us interesting to ascertain the nature of the gluten which gives adherence and solidity to these sands, and which produces the numerous arenaceous agglomerations the sea throws up on its shores. By separating the shells and their debris from these shelly rocks, and treating them with chlorhydric acid, which dissolves the smallest detritus of the shells not separated by mechanical means, a residuum remains, which presents the physical qualities of clay. This kind of mineral gluten, then, is analogous to Roman cement; like it, it is very plastic, and hardens and solidifies under water. We may add that a clay quite analogous, and which produces the same effects, is found on the shores of the ocean, principally on the coasts near Havre, where one of us observed it.

Although these shelly rocks are found on the shores only in small, and almost always insulated masses, it is yet probable that they constitute, in the middle of the seas, large and extensive masses, of which we find only the fragments. It cannot be doubted that they are formed in the middle of the salt waters, when we remark, that the part which does not rest on the bottom is often covered, not only by Annelides of the genus Serpula, but also by different Zoophytes. We sometimes also find Barnacles upon them, as on many of the fossil remains of terrestrial mammifera which have been carried into the sea in geological times.

The formation of these shelly sandstones presents a great number of curious circumstances, which we shall rapidly point out. Metallic objects remaining long in the sea, become, as it were, centres of attraction for the substances in solution in the waters. These substances are precipitated on their surface, and cover them with a coating often of very considerable thickness and hardness.

We possess a musket which appears to have lain long in the sea. It is covered with a sandy shelly layer, from 5 to 6 centimeters thick, and of great hardness. In our collections we possess many iron instruments, shewing the same peculiarities. We have exhibited to the Academy the blade of a knife, still adhering to its handle, which has been surrounded by a layer of shelly sand nearly 4 centimeters in thickness. Besides the fragments of shells collected by us, and hardened by means of a ferruginous cement, which compose this kind of rock, we also observe small pebbles in it, like those generally found in the sea. We can easily perceive, from the examination of the knife thus encased, the influence which the oxide of iron has exerted on the production of the cement which agglutinates the sand, the shells, and small pebbles. The iron composing the blade and the nails of the handle is converted into limonite or hydrated peroxide, and, by spreading through the mass of sandstone, it has communicated a considerable solidity and hardness to this new rock.

The phenomenon which we have seen exemplified on small objects, is likewise produced on a large scale, and in circumstances too curious not to be at least rapidly noticed. In 1827, by the advice of Davy, the English Admiralty caused the copper sheeting of vessels to be covered with a certain number of plates of zinc, in order to oppose, by a galvanic action, the rapid corrosion of the metal in sea-water, particularly in some parts of the coast of Africa. But this expedient had soon to be abandoned, because considerable deposits of shells and agglutinated sand encrusted the vessel so rapidly, that its progress was retarded. Here the galvanic action accelerated the phenomenon. The copper, rendered negatively electrical by the pile formed by the superimposed zinc and copper, attracted the insoluble bases, the magnesia and lime held in solution in the sea-water, and the sides of the vessel began to be covered with carbonate of lime and magnesia; the shells and sand were then precipitated on these earthy deposites. The electrical action induced and accelerated the phenomenon, but it is evident that it is entirely of the same order as those we have been examining.

V. *Have the Physical Phenomena of the Ancient World any Analogy with the Phenomena now taking place?*

The preceding facts prove that the petrifaction of shells is not a phenomenon peculiar to past ages, since it is still observed in our own days. This phenomenon cannot, therefore, be brought forward against the opinion of the actual permanence of the causes which have operated in the geological epochs. But it may be asked, whether this fact be unique, and whether the other phenomena of the material world concur with it in inducing us to admit that there is no change in the operating causes, unless it be that they exercise their action with less intensity, and in a less general manner. It forms no part of our intention to discuss this question,—one of the most delicate and important connected with geology, in all its details,—in this place. We shall confine ourselves to examine briefly whether other facts do not strengthen that one we have been studying, and, like it, prove that the same effects have been always produced on the surface of the globe.

If we turn our attention to peat-mosses, the most abundant deposites of carbon we now possess, they will give us, in their alternate beds of marl and sand, a very accurate idea of the conversion of ancient forests into coal. Besides, immense rafts of wood, which the great rivers of America bring down to their mouths, are often transformed, when subjected to great pressure, into a carboniferous matter analogous to coal itself. Lastly, when wood is found in suitable circumstances, such as an elevated temperature, or a considerable pressure, it is converted into lignite, very nearly in the same manner as trees were under the same conditions, in geological times. There are no longer formed, it is true, deposites of ferrate of iron similar to those wrought in Sweden; but ferruginous deposites have by no means ceased to be produced, for they are daily forming in lakes and marshes. These consist principally of limonite (hydrate and peroxide of iron), which is found sometimes in suspension in marshy or lacustrine waters, sometimes disseminated through sandy formations. To the examples of this previously known, M. Daubrée has recently added another, which he has described to the Geological Society of France (1846.) This fact is not less remarkable than those which had formerly been noticed. On the other hand, the numerous stony beaches filled with marine shells, forming every day in so many different places, represent, in the whole of their characters and texture, the coarse limestone or *calcaire moellon*, both so replete with the remains of molluscs; they are both solid and hard. Among the deposites produced every day under our own observation, we may mention those of the Straits of Messina, the harbour of Copenhagen, coasts of Ceylon, the Bay of Sea Dogs, of New Holland, and Guadaloupe. The Antilles also afford many examples of these modern formations. It is the same with those of the Island Anastasius (*Santo Anastasio*), near the east coast of Florida, opposite the Port of St Augustin. The solid marine beds which are constantly precipitated, and envelop the living shells, compose agglomerations which harden so rapidly as to admit of being employed for building. These stones are even much sought after, on account of their lightness and solidity: they have the advantage of resisting the action of projectiles without cracking, balls sinking into them.

The shelly sandstones of geological times have their analogues, not only in those produced in our own day in the Mediterranean, but also in the siliceous banks formed on the shores of the ocean. M. De la Bèche cites a very remarkable example of this on the north coast of Cornwall. These sandstones are so solid that, in a steep shore which is formed of them, they have dug out caverns at New Park to afford shelter during embarkation. They have even built the church of Crantoch, which is very near, of this material.

Banks of pudding-stone, so numerous and extensive in geological times, are still forming in the present day. One in particular is mentioned between Dives and the mouth of the Orne. There is a vast collection of rolled pebbles, mingled with shells which have still the freshness of living species. These agglomerations are cemented with carbonate of lime, formed in part by the triturated debris of some of these shells, as MM. Constant Prevost and Huot have observed. In like manner, siliceous sediments are deposited every day from mineral springs in an indefinite number of places. These sediments correspond to similar deposites of geological times.

Modern travertins remind us in every respect of the travertins of geological epochs. The former form layers as distinctly stratified as the latter, which shews, as Mr Lyell remarks, that they have been produced by the same cause.

No doubt these facts are insufficient to prove that all the phenomena of the old world are continued in the present day, but they are calculated to make us presume so in regard to the majority of such as are best known to us. Now, it is rational to suppose that such also must be the case with respect to those facts to which we have not yet directed our attention. It is then extremely probable that the same laws have always regulated physical phenomena, to whatever epochs they belong, for unity has been at all times the essential character of the works of Nature.

Conclusions.

The facts we have stated lead to the following conclusion :—

1*st*, Shells which have lain for a long time in the Mediterranean petrify there, just as they petrified in the basin of the ancient seas.

2*d*, The fossilization of the shells of the old world, and the petrifaction of shells in the basin of existing seas, were effected in the same manner, and constitute two similar phenomena.

3*d*, The petrified shells of the old world, and those now met with in the same state on the shores of the Mediterranean, are almost identical in regard to their chemical composition.

4th, The difference which exists in the mode of substitution in the present day and in geological times, consists in this, that the petrifaction formed at these two epochs have a different texture and molecular constitution; it is essentially crystalline in the former, while it is compact in the petrifactions of the old world.

5th, Shells petrified in the present day do not arrive at this crystalline texture till after they have passed through a certain number of stages, easy to be observed. They begin by losing their colour; then the inequalities, asperities, and expansions of their surface disappear, and they become quite smooth. Finally, the penetration of the calcareous fluids causes their transformation into a stony mass, most commonly crystalline, and sometimes having the appearance of alabaster.

6th, Univalve shells petrify less easily than bivalves. The loose and foliated structure, such as is observed in oysters, seems to facilitate the penetration of the lapidifying liquids.

7th, The black tint which shells often acquire by lying in sea-mud, arises from the reaction of sulphuretted hydrogen, spontaneously disengaged from the mud, on the oxide of iron which these shells contain. This phenomena has no connection with petrifaction.

8th, The phenomenon of petrifaction is very little perceptible on bones in modern times. By lying in the Mediterranean, they merely acquire greater density and solidity.

9th, There are formed, in our own day, in the middle of the waters of the Mediterranean, banks of shelly sandstones which represent the analogues of the shelly sandstones proper to geological formations.

10th, These shelly sandstones are produced with great facility around all metallic objects which remain pretty long in the sea.

11th, The phenomena which we have proved as existing in the Mediterranean probably take place in the ocean; and it will be easy to ascertain this when naturalists turn their attention to it.

The facts contained in this memoir concur, then, with many others, to prove that nothing is changed in the order of Nature, and that the thread of her operations is not broken.*

* From Annales des Sciences Naturelles, Jan. 1847, p. 21.

On "the Silurian Rocks of Bohemia," uith a few Remarks on the Devonian Rocks of Moravia, in a Letter to Professor LEONHARD from Sir RODERICK I. MURCHISON. With a Plate. Communicated in Manuscript by the Author, through M. LEONHARD, for the Edinburgh New Philosophical Journal.

MY DEAR SIR.—I avail myself of a day of leisure, to give you a brief general view of the Silurian system of the centre of Bohemia, as it has been most correctly named by M. Barande.* To you who have kindly undertaken to make better known to the scientific public of Germany, the results of the researches of my colleagues, M. De Verneuil, Count Keyserling, and myself, I have only to refer to the first chapter of our work, to remind you of the very great importance which is there attached to the labours of M. Barande. I first visited Prague in 1829, secondly in 1843, and now I have spent a fortnight there in company with M. De Verneuil, in the latter part of which we were joined by Count Keyserling. During the first visit, I knew no more of the succession of the palæozoic series of rocks and fossils beneath the mountain or carboniferous limestone (*berg-kalk*), than any of my brother geologists of Europe; and my fellow-traveller on that occasion, Professor Sedgwick, and myself, having chiefly in view the development of the structure of the Eastern Alps,† we satisfied ourselves with an excursion along the left bank of the Moldan, where, under the guidance of the able mineralogist Professor Zippe, we saw that large masses of limestone with trilobites were subordinate to rocks which were then, without distinction, termed "grauwacke," or "transition." With the exception of a few trilobites, chiefly those described by Count Sternberg,‡ the museum of Prague then offered few palæozoic fossils. Time rolled on, during which, by several

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* See Notice Preliminaire sur le Systeme Silurien, et les Trilobites de Bohème par Joachim Barande. Leipsic, 1846, p. 1.

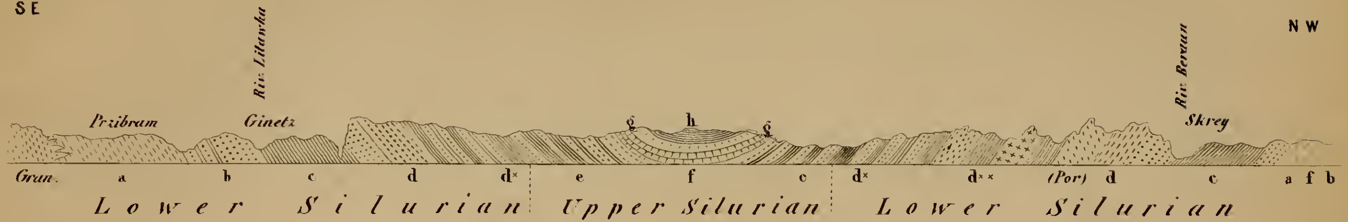
† See Transactions of the Geological Society of London, New Series, vol. iii., p. 301, and Philosophical Magazine, New Series, vol. viii., August 1830.

‡ See two Notices of Count Sternberg 1825 and 1833, in the Verhandbenger des Vaterlandesches Museum, Prague.

years of researches in England and Wales, I established the Silurian system as a true natural "terrain," which, characterised by peculiar organic remains, is separated from the mountain limestone above it, by the great deposit of the old red sandstone. This first step was the prelude to the subsequent labours of Professor Sedgwick, M. Landale, and myself, whereby the "Devonian system" of fossiliferous limestones, schists, sandstones, &c., was shewn to be the equivalent of the old red sandstone. In this manner the relations of the older series of fossiliferous strata having been unravelled, the next step was to apply this basis of classification as exhibited in Britain to Europe and other countries, and see how it would there stand the test. You know the part I have borne in carrying out this project; and I only allude to it to inform you, that it was on my return from Poland and Silesia in 1843, whilst I was making certain additions to the work on Russia, that I next visited Prague, and then, for the first time, became really convinced of the fact, that to whatever extent the Silurian rocks were to be recognised in Germany (the strata beneath the carboniferous limestone of Belgium and Rhenish Prussia chiefly representing the Devonian system), there could be no doubt that M. Barande had succeeded in demonstrating, that the palæozoic rocks of the tract around Prague were of true Silurian age. He had, in fact, even in 1840 (and immediately after the publication of my classification), communicated to me his opinion, that the Bohemian deposits were of the same age as those I had described and classified. After making an excursion with him to view the order of the limestones and shells, I never shall forget the surprise and delight I felt in seeing the rooms and cabinets of this accomplished private gentleman, absolutely loaded with organic remains, nine-tenths of which had certainly never before been laid before geologists; nor did I hesitate a moment in confirming the conclusions at which M. Barande had already arrived, by comparing his fossils, and the rocks in which they are embedded, with the animal forms and sections of my Silurian system. Since that time, M. Barande further communicated to me, that there existed a very clear distinction between the upper and lower Silurian rocks of Bohemia, in mineral character and superposition, as well as in organic remains; and hence, I had no hesitation in announcing the fact in the opening chapter of the work on Russia. I always intended, however, to enjoy the pleasure of examining in detail the best transverse sections of the Bohemian basin, and little persuasion was required to induce my colleague, De Verneuil (who, in the interval, has brought the Silurian and other palæozoic rocks of North America into an exact parallel with the European series), to join me in an excursion, during which he might rigorously scrutinize the collections of M. Barande. Having also been joined, as before said, by my other colleague, Count Keyserling, so distinguished by his writings on the palæozoic rocks of the wild regions of the Petechora, I confidently assert, in the name of my friends and self, that the collection of Silurian fossils, made by M. Barande, is by far the richest yet made known to any one region of Europe—if not in the globe. I am therefore naturally anxious to offer a brief sketch of so remarkable a basin, the most striking points of which I have now explained. Admiring the beautifully diversified animal forms which M. Barande has brought to light, my friends and myself cannot too much extol his labours of the last ten years, nor adequately commend the spirit of enterprize and love of science which have sustained an unaided French gentleman, who, by the very liberal employment of his own pecuniary means, has opened out many quarries in search of these ancient medals of creation; and who, by a sound judgment and penetrating discrimination, has himself successfully classed, and is now describing nearly 800 of the Silurian fossils, each group of which distinguishes a well-marked physical horizon. The extreme precision with which M. Barande has handled this difficult portion of his subject is, indeed, beyond all praise; and whether I consider his labours in a field full of complication, or in the cabinet, and behold their fruitful and well-digested results, I must, in justice say, that his work, when completed (32 of its 120 plates of fossils being already finished), will be one of the

Edin.r New Phil. Journ. Vol. 44, p. 69.

SILURIAN ROCKS OF BOHEMIA.



Order of the Strata

Por. . Porphyry

Gran . Granite

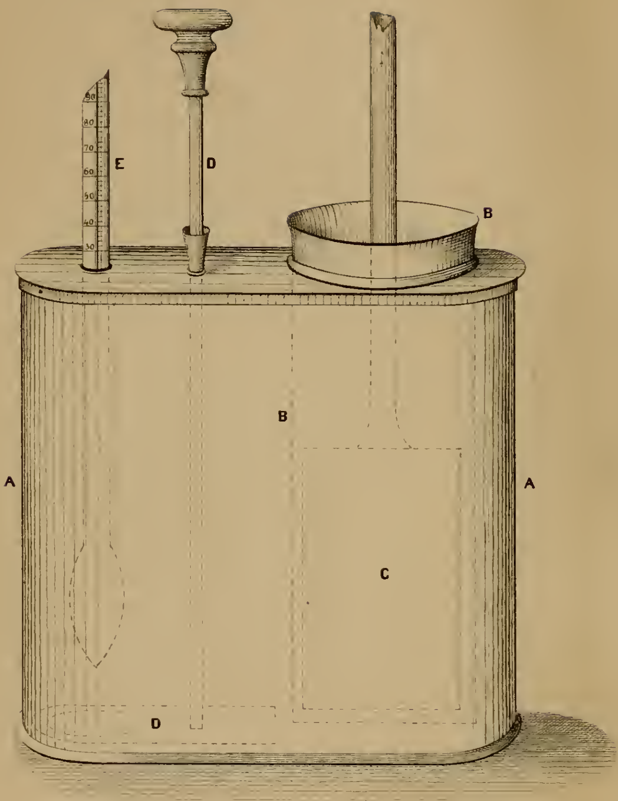
Upper Silurian

- h *Uppermost Silurian Shale.*
- g *Upper Limestone.*
- f *Middle Limestone.*
- e *Lower Limestone & Graptolite Schist with intrusive & contemporaneous Greenstone & Schaalstein.*

Lower Silurian

- dˣ *Upper quartzose flags, Sandstones & Schists with Trinuclei.*
- dˣˣ *Quartz rocks (Kiesel, Schiefer, local)–*
- d *Quartz grits, conglomerates &c.*
- c *Lower Schists with Paradoxides & Bathis.*
- b, a } *Grauwacke grits & Schists the lower beds near Przibram in contact with & pierced by Granite*

Fr. Schenck Lith. Edinburgh



A A Represents oval vessel of sheet iron nearly filled with Mercury. (external wooden case removed.)

B B Tube of iron immersed in Mercury, to receive the heated cylinder.

C The cylinder, under which, a thin layer of sand.

D D Plunger to assist the convection of heat

E Thermometer.

Fr Schenck lith. Edinburgh.

very best and most interesting monographs which has ever enriched geological science.*

Referring your readers to the annexed transverse section across the broadest part of this Bohemian basin which contains fossils, and excluding from our view those inferior rocks in which no fossils have been discovered, it may be stated that, so defined, the Silurian rocks there extend from NE. to SW., through a distance of about 10 German miles, and have a maximum breadth of about 3½ miles from NW. to SE. This direction of the major ellipse of the Bohemian basin is the same as that of the typical Silurian rocks of Britain, and, like the British type, consists of two great divisions. The outer zone, representing the lower Silurian rocks, and composed of schists, shale, conglomerate, and quartzose rock, encircles and dips under an ellipsoid of limestone and shale, which represents the upper Silurian. The external zone, or that in which the oldest fossils have been found, is marked in its lowest stage by an earthy schist of greyish and dull green colours, (*c* of section, Plate II.) which is, in truth, a very good representative of the " mudstones" and " rotch" of the Silurian Regions, like which, it is devoid of any distinct slaty cleavage. At the places where we examined this rock, (Ginetz on the one side, and Skrey on the other side of the basin) it is scarcely to be distinguished from other schists (*b*) which underlie it quite conformably, and are intercalated in quartzose and conglomerate greywacke, similar to that which at Skrey is seen to overlie the fossil stratum (*c*.) These underlying rocks, (*a* and *b*) which M. Barande has very properly distinguished from the overlying by their

* Since M. Barande issued his " Notice Preliminaire," and gave the first correct general sketch of the Silurian basin of Bohemia, with an account of 115 species of trilobites, MM. Haule and Corda have published a prodromus of a publication on the Bohemian trilobites, in which I regret to observe that no allusion is made to the meritorious discoveries of M. Barande. I leave to palæontologists to decide eventually on the value of a work in which the authors profess to describe 329 species of Crustaceans! but, on the part of my friends and self, I must protest against their geological view, that all these diversified and finely laminated strata were contemporaneous or nearly so, and cannot be separated into groups of successive ages.

want of fossils, seem, however, to me to be so allied by mineral characters, and conformity of dip and strike, to those which overlie them, that they must be considered to form as truly the natural bottom of the Silurian basin of Bohemia, as the siliceous sandstones and arkose of Sweden, and the lower shale of St Petersburg (both equally void of all fossils except fucoids), constitute the base of the Silurian rocks of these countries.

Amid the numerous species of trilobites contained in the lower schists (*c*), it is worthy of remark, that one species (the *Paradoxides Tessini*) is identical with a form which specially characterises the lowest fossil band in Scandinavia, like which it is also associated with the *Battus* or *Agnostus*. The specimens of the latter genus exceed in consolidation and perfection any thing which the rest of the world has offered, and have been the first to explain the true form of this most curious crustacean, with its rounded head and pygidium united by two body segments only. Among the few Orthidæ discovered in this band of trilobites, is the *Orthis Romingeri* (Barr.), which is very closely allied to the *O. testudinaria*, so characteristic of the lower Silurian rocks of Britain and other parts of Europe, and which M. De Verneuil has recognised as one of the surest types of the lowest Silurian strata of North America.

These trilobite schists are surmounted by quartzo-schistoze masses ($d\ d^{xx}$ and d^{x} of the section.) This order is clearly seen near Ginetz on the one side of the basin, and at Skrey on the other, in the gorge of the Beraun, to the west of that village. At the first mentioned places, the rock overlying the schist is a slighly ceyloneritic quartz rock, which passes upwards into a great mass of siliceous strata, constituting a lofty ridge, usually occupied by forests; but those relations to the superjacent, as well as to the subjacent strata, are well exposed in the deep narrow valleys of the Beraun and Litawka on either flank of the basin. On the right bank of the Beraun, near Skrey, the ceylonerite above the trilobite beds is composed of coarse materials, for the most part rounded, of white quartz and black lydian stone, varying in size from that of small pebbles to the dimensions of a man's head. The matrix is chiefly made up of the detritus of the underlying schist, in one of the harder fragments of which I observed a portion of a Paradoxides. With some local exceptions and numerous dislocations towards the north-eastern extremity of the tract, there is a more perfect symmetry in the ascending series, on whatever side the section be made, than any other, of the same dimensions and age, with which I am acquainted. I will not here speak at length of the porphyry, kiesil-schifer, hornstone (*d c*), &c., which occur on the north-western side of the basin, which with certain bands of heavy, dark, quartzose grauwacke, give a peculiar aspect to the lower portion of this division, as seen between Nyschburg and Skrey ; but I must observe that the iron ores in it are scarcely to be distinguished in mineral aspect from those of Dillenburg and other places in Nassau. There Bohemian pisolites are, however, quite distinct from those of the Lahn and Rhine, both in geological position and zoological contents ; for they occur in the very heart of the lower Silurian Rocks, and instead of Devonian fossils they contain Echinosphientes, belonging to Cystideæ, those earliest crinoids which have alone been detected in the lower Silurian strata, and which have been so admirably described by Leopold von Buch. Although this is not the occasion to treat of the influence produced on the marine deposits by the eruption of porphyry, greenstone, &c., with which this tract abounds, nor of the varied structure and contents of the mineralized district near Przibram, I shall, however, presently allude to some igneous evolutions intimately connected with the sedimentary succession. The superior masses of the quartzose series are chiefly characterised by a profusion of trilobites, the type of which is the Trinucleus—one species being, in my opinion the *T. caractaci* (mihi), and another the *T. ornatus* (Sternberg). These, with various forms of Phacops, Calymene, Asaphus, and Odentopleura, &c. are associated with the *Orthis redux* (Barr.), a form similar to one of my Caradoc fossils. It is specially where these quartzose rocks begin to pass upwards into alternation with soft black schists, that a new source of interest awaits the geologist. He is here on the upper limit of all those rocks to which the term "Lower Silurian" has been applied, whether in Europe or America ;* and in proceeding from that protozoic division to the next in ascending order, he cannot fail to remark, that many masses of eruptive rocks are interpolated, some of which have been most certainly formed contemporaneously with the ordinary sedimentary strata. The lowest of these eruptive rocks contains already more lime, whether in amygdaloids or disseminated, than is to be detected in all the subjacent lower Silurian strata ; and each superior course of this eruptive matter is more and more charged with carbonate of lime in a basis of felspathic greenstone. In truth, when the rock alternates with the graptolite schist and lower limestone of Barande, (*e* of section), it is perfectly undistinguishable from many of those bands of " schaalstein" which are familiar to you, as well as other German geologists in Nassau, and is not unlike some of the contemporaneous Silurian volcanic grits described by me in Shropshire and Radnorshire, or the " volcanic ash" of De la Beche. In Nassau the " schaalsteins" are subordinate to true Devonian rocks, but in Bohemia they occur in the lowest stage of the upper Silurian division (*e*). This stage is instructively displayed on the left bank of the river Beraun, below the town of that name, where it is clearly seen to repose on the schists and quartzose rocks, or upper beds of the lower division, and is surmounted by the limestones (*f*, *g*, and *h*). The bottom beds contain numerous forms of the most beautiful graptolites I ever saw. Thin layers of black limestone occur, and then the shales contain round and spheroidal nodules of black earthy limestone, in which M. Barande has found many of his best fossils. Bands of " schaalstein," passing on the one hand into a coarse-grained greenstone, and on the other into amygdaloidal trap, succeed, until the group graduates upwards into a solid limestone, usually of dark colour, which is absolutely loaded with Orthoceratites, Phragmoceras, and other chambered shells, and is also peculiarly distinguished by containing *Cardiolæ.* The surfaces of the upper portion of these lower limestones are marked by numerous

* De Verneuil's Table of Classification of the Palæozoic Fossils which mutually occur in North America and Europe. Bulletin de la Soc. Geol. de France, 1847.

corals, including the *Centenipora escharoides,* so characteristic of the Silurian rocks, and which has never yet been found in the Devonian, together with the *Terebratulu linguata* and *T. imbricata* or *marginalis* of Dalman, which occur in the upper Silurian rocks of Wenlock and Dudley in England, and of Gothland in Sweden.* In speaking of the contemporaneity of the trap-rocks of this part of the Silurian series of Bohemia, to you who have so distinguished yourself in this department of our science, I must explain myself. Some of the greenstones and amygdaloids in question have certainly been erupted in amorphous masses, which have broken irregularly through the limestone and shale, and have often, to a great extent, fractured, indurated, and altered them. Such masses have, therefore, fairly burst through pre-existing strata; but this eruption having terminated, the bottom of the sea in which the phenomenon occurred, evidently resumed, to a great extent, its tranquillity; for the upper portion of the plutonic rock assumes a bedded form, and is followed in the ascending order by numerous thin courses of "schaalstein," interlaminated with black schists and nodular limestone, all of which strata are conformable over considerable areas. This phenomenon, which I have studied in other countries, even Siberia, in company with De Verneuil and Keyserling, I have always thought can only be explained either by supposing that the cinders or ashes derived from the eruptive *foci* were regenerated into deposits with alternating courses of calcareous mud, or, as is more probable, that successive partial disturbances of the sea-bottom furnished fresh submarine volcanic materials during a certain period, until the volcanic action entirely ceased.† The lowest member of the upper Silurian Rocks of Bohemia is overlaid by limestones of considerable thicknesses, which M. Barande has very properly divided into two formations (*f* and *g* of section), by observing, that however united in physical aspect, each is dis-

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* See Murchison's Description of the Silurian Rocks of Sweden, Journal of the Geological Society of London.

† Here, as in the Rhenish provinces, Britain, and elsewhere, organic remains occasionally occur in the "Schaalstein."

tinguished by fossils peculiar to it, and distinct from those of the underlying limestone. The middle limestone (*f*) is, for the most part thin-bedded ; but at Karlstein and other places it assumes a nodular or concretionary structure ; even then, however, it only partially contains the thinnest films of shale between the beds of limestone, and is usually a hard sub-crystalline united congeries of thin strata, having a thickness of 300 or 400 feet, the colours of which vary from whitish to light grey, and reddish, and occasionally even to blackish tints. Its chief fossils are Brachiopods and Trilobites, and of the former, I may enumerate *Terebratula princeps*, (Barr.), and its associates ; *T. Wilsoni*, with Pentamenes, Sperifer, Leptæna, &c.

The upper limestone is more compact and thick-bedded, and is of about the same thickness as that beneath it. In a transverse section, which passes from the deep gorge of St Iwan to Hostin, as in a few other places, this rock is seen to be overlaid by brown-grey shale, very slightly micaceous, alternating with a few courses of very thin-bedded psammite, and very impure limestone. This upper band is distinguished by a few Trilobites only, one of which is the well-known *Phacops Hausmanni*. In his " Notice Preliminaire," M. Barrande has compared these three stages of calcareous strata with the upper Silurian subdivision, as given in my original work ; and has ably pointed out, that although agreeing on the whole with the upper Silurian of the British isles, the Bohemian division is characterised by local peculiarities in the distribution of the fauna. This observation of so good an observer is well worthy of notice. So far from invalidating the conclusions at which I arrived twelve years ago, when I published my first Synopsis of the Silurian system,* it confirms them in the strongest manner. I then, and in every subsequent publication, specially requested geologists to consider my *sub*-divisions of upper, middle, and lower Ludlow, and upper and lower Wenlock, as mere local British examples, which, even in my own country, were not mineralogically nor zoologically traceable for any great distance.

* See Philosophical Magazine, London, June 1835.

I emphatically requested all those who would apply my classification to distant parts, to look to *two* great natural portions only, into which the Silurian system might be expected to divide itself in other countries, viz. "Lower and Upper Silurian," the local distinctions in each of which would probably be found to be various in different countries; whilst the general distribution of the fauna in each would, I hoped, be proved to harmonize with the physical and zoological arrangement of one great natural system. It is in this point of view that the Silurian system has since been applied to various parts of Europe and North America, and has been found to stand the test. But however the smaller subdivisions of distant countries may differ from each other, I would here remind geologists, that in these ancient rocks, as well as in those of secondary age, similar types of organic life frequently occur on the same horizon in distant lands, when similar mineral conditions are repeated. Thus, in the lowest fossilliferous schists of Ginetz and Skrey, we are reminded of the Llandeilo flags and schists of England, and of the Alum-Slates of Sweden, by the development of large Trilobites, and the genus Battus, which, together with Orthidæ and Cystideæ, peculiarly mark these deposits. In the overlying quartzose rocks of Bohemia, we cannot fail to be struck with their analogy to the Caradoc sandstone (even in Britain often in a quartz rock); and so impressed was I with this resemblance of these siliceous flagstones of Bohemia, which are loaded with *Trinuclei*, to my British types, that if I had seen these specimens in any cabinet, I would have said that they came from the Caradoc group of the lower Silurian rocks of my own country.

Then, as to the upper Silurian, it strikingly resembles the British division of the same age, in being like it eminently characterised by a multitude of chambered shells (Orthoceras, Phrogmoceras, Cyrtoceras, Lituites, &c.), some of the characteristic species of which are most abundant in the very heart of this upper division in England; viz. in the shale between the Ludlow and Wenlock rocks. Again, the middle group of the upper division of Prague contains large Pentamenes, one of which is undistinguishable in external form from the *pen-*

tamenes Knightii of the middle limestone of the Ludlow rock, and in Bohemia, as in England, it is associated with the well-known *Terebratula Wilsoni.* In reference to the trilobites which occur in the *upper* Silurian of Bohemia, I hope I may be excused for saying, that I was peculiarly gratified to observe, that the lower stage of the limestones of this age contains, as in England, the Bumastus (mihi) ; and that of the two species collected by M. Barande, one is scarcely distinguishable from my *B. Barriensis.* Now, while I state with some confidence, that no such species has been found in the lower Silurian rocks, I equally maintain (mere geologist as I may be), that, despite of the criticism of the learned naturalist Barmeister, the genus *Bumastus*, as defined by me, is well established, and never can be united, as he suggests, with the true lower Silurian genus *Illænus*, from which it is at once distinguished, by its completely round and perfectly untrilobed (without trilobation) pygidium, whilst it is as absolutely separated from *Nileus*, by the number of segments in its body.

If time permitted, I could now run on in enumerating a remarkable number of additions to the natural history of geology, which will be made known and illustrated by the work of M. Barande ; but intending to give you a mere outline of what may be expected from him, I may inform you, that amid many analogies and identities, to some of which I have already alluded, the Brachiopoda alone offer about 30 species which are absolutely identical with British and Silurian types.

I will now conclude this letter, by informing you that Count Keyserling, De Verneuil, and myself, have examined the tract around Olmutz, subsequent to our visit to Prague. When Professor Glochar of Breslau, sent to your Journal a brief communication on the nature of the limestone of Rittberg, and the environs of Olmutz, surmising that it was of Silurian age, your valued coadjutor, M. Brown suggested, in a note, that it was probably, however, of Devonian age, as the fossils were like those of the Eifel. Since then, some additional

* See Jahrbuch, 1842, p. 42.

fossils were collected from Rittberg, to the SW. of Olmutz, by M. Geveril and Koch, and having been sent to the young M. Hörnes of Vienna to be named, my friend Count Keyserling at once said that they must belong to a Devonian group. Still the tract required examination, and it is after a circuit by Nebetein to Grosse, Luttein, Rittberg, Cyllechowitz, and Ollscham, and after collecting a good many fossils, that we came to the conclusion without a doubt, that these rocks belong to the Devonian system. The fossils which have been scrupulously examined, are Bronteus, two species, Trilobite (pygidium only of a small species), Turritella, *Macrocheilus*, closely allied to the *M. arculatus*, and to the species of the Hartz, *Bellerophen tuberculatus*, Maclurites, (species undetermined), *Euomphalus* two species, one of which most resemble one of the Eifel, *Lucina proavia*, *L. Dufrenoyi*, andt wo other species, Modiola (species undetermined), Terebratula reticularis, *T. concentrica* (small variety), *T. pugnus* (a variety which occurs in the Hartz, *T. mycrorynchus ?*) T. smooth species of the *T. virgo*, *Strigocephalus Burtini*, *Spirifer heteroclitus*, S. species undetermined, Leptæna depressa, Porites interstincta, Favosites Gothlandica, T. spongites, *Lithodendron cæspitosum*, Cyathophyllum turbinatum, Fenestella antiqua, Cystiphyllum, &c.

In these fossils we recognise at once, some of the most characteristic types of the Devonian age, such as the Strigocephalus, associated with Lithodendron cæspitosum, and others, which are above named in italics. The trilobites and chambered shells of the upper Silurian rocks, are no longer present, and with the exception of two or three shells, and a few corals which are common to the upper Silurian and Devonian, the type is on the whole very distinct; no really characteristic Silurian species being present, and the *Catenipora escharoides*, that true Silurian coral, not being observable.

As to the character of the limestones of Olmutz, I would repeat the observation which has been made by Professor Sedgwick and myself, as to the British and Rhenish deposits of the same age, viz.:—that though of posterior date, they have often a more ancient aspect, and more resemble primary limestone, than any portion of the upper Silurian masses. This is so remarkably the case in the little ridge between Nebetein and Olseham, which is thrown up in an anticlinal form, and where the highly veined hard and scaly crystalline limestone is so associated with talco-micaceous schists, that if we had not found fossils in it, we might have well presumed that it was of much higher antiquity. At Rittberg, bands of whitish hard quartzose conglomerate dip under the black Strigocephalus limestone, and thus represent the sandstones, grits, &c., which occupy a similar place in the Rhenish provinces; whilst, at Gross Luttein, the limestone is overlaid by a coarse grit and hard sandstone, in parts conglomeritic, whose exact relations we had not time to determine. This last mentioned rock occupies the higher woodlands, and in mineral character is not unlike some varieties of the Carpathian grit; but not being able to observe a junction, we forbear from attempting to determine the point. In the mean time, it is enough to observe, that as up to the present day, the grauwacke and limestone of the environs of Olmutz, have not been dissociated on geological maps from the grauwacke and limestone of Bohemia, so is the value of the palæozoic classification made apparent. From what I already know of the existence of true Devonian rocks in Upper Silesia, and the country of Glatz, and from noticing great masses of ancient stratified rocks on the western borders of Moravia, which, on the whole, plunge under the Devonian rocks of Olmutz, I have little doubt that a zealous geologist, who could devote a summer to the task, would be able to demonstrate that strata of true Silurian age, like those of Bohemia, are also to be detected in Moravia, and on the south-eastern flanks of the Riesengebirge, and in the tract between Troppau and Olumtz. At all events, it is to be hoped that the types of both these systems being now pointed out in this central region of Germany, the time will shortly come, when their respective limits will be accurately laid down.

I presume you are aware, that since Professor Sedgwick and myself indicated the existence of certain large Producti, &c., of the carboniferous age near Bleiberg in Carinthia, which there surmount crystalline rocks, with encrinites of the

Tauern Alps,* other palæozoic fossils have been found on the northern side of the crystalline axis of the Eastern Alps, and notably at Dienten, to the south of Salzburg.

Having inspected some of these fossils from Dienten, kindly shewn to us by the Chevalier V. Hauer, which are in Montanishtische Museum of this place, M. De Verneuil and myself are of opinion, that they belong to the upper Silurian group; and my friend further believes, that they are of the same age as the Silurian schists of Feugerolles in Normandy. We are now about to proceed into the Austrian Alps, on our way to the meeting of the Italian Naturalists at Venice, and in this journey we hope to gain some additional information on this interesting point; it being now evident, that the Alps, as a whole, are not composed of rocks of a more recent date, but they exhibit towards their centre, sufficient evidence that numbers of the masses of schist, grauwacke, and limestone, now in a highly metamorphic condition, and which are flanked on both sides by limestones of Liassic and Jurassic were originally members of a regular palæozoic series.

Believe me to be, my dear Professor Leonhard, your faithful friend,

RODERICK I. MURCHISON.

VIENNA, *August* 5, 1847.

On the Height of the Aurora Borealis.

By G. A. ROWELL.

In a paper I submitted to the British Association at the late meeting, I endeavoured to shew the correctness of the theory which I first submitted to the Ashmolean Society in November 1839, on the cause of the aurora; that is, that electricity rises with the vapour in the torrid regions, and is carried thence by the *superior* trade-winds towards the colder

* See Transactions of the Geological Society of London, vol. iii. p. 307.

parts of the earth, where, at times, the air, during severe frosts is rendered so dry and non-conducting, that the electricity is prevented from escaping from the clouds and vapour to the earth in those parts; and therefore accumulates, till it flashes back through the upper and rarer air towards the warmer and more negative parts of the earth, and thus causes the aurora.

The opinion so generally received, that the aurora is at times at such heights as to be far above the limits of our atmosphere, is so directly opposed to this theory, that one or the other must be erroneous; I therefore suggested that the observations which give such altitudes to the aurora, may be incorrect, either from some error in the observations, or from some other luminous meteor being taken for an aurora, or from some optical illusion in the observations.

At the conclusion of my paper, Professor Challis stated that he had (at Cambridge), in conjunction with Professor Chevallier (at Durham), taken the altitude of an aurora, which gave positive proof of its being at least 160 miles high, and consequently far above the limits of the atmosphere. I, of course, could not doubt the correctness of these observations; but as I was not convinced that my own views were wrong, I have been led by several reasons to conclude that the error must be owing to some optical illusion.

In the first place, the fact, that the auroral corona is never seen except in or near the zenith, shews that it is an appearance only, and not in reality a convergence of auroral streams to one point, as in that case it would at times be seen at every point of the compass, according to the situation of the observer; and auroral streamers would at times be seen crossing the sky in an oblique direction, instead of always rising nearly perpendicular to the horizon.

It is shewn by Lieutenant Hood, that auroral arches are only so in appearance, "as the auroræ which filled the sky at Cumberland House, from the northern horizon to the zenith, with wreathes and flashes, assumed the shape of arches at some distance to the southward;" and I believe the reports on the aurora of the 24th of October, by Professors Challis and Chevallier, in the Athenæum for November 6; by Mr Glaisher, in the philosophical Magazine for the present month; together with my own observations in the Oxford Herald for October 30, will prove that no calculations founded on the apparent altitude of an aurora can be depended on; that Auroral *Coronas, Streamers, and Arches* are only appearances and optical illusions; and that no two observers can see any of these Auroral phenomena at exactly the same time and place, any more than two persons can see exactly the same halo; or, when looking at the same cloud, can see exactly the same rainbow. There are many discrepancies in these reports, both as regards time and appearances. Professor Chevallier says, "bright streamers, some *white*, others of a light *green*, were seen shooting upwards from the northern and north-western parts of the sky before half-past six o'clock; and at intervals a *slight* crimson flush was observed alternating with the streamers, and diffused over the neighbouring parts of the sky." Mr Glaisher states, that "about 6^h 30^m, a bright *red* streamer was seen to spring up from the north-west; at 6^h 40^m another streamer was seen in the north-west; and at the same time one sprung up from the north, both of which were of a *beautiful red*." Whilst at Oxford, "about a quarter past six o'clock, a faint red colour overspread the north-western horizon, and at the same time a slight appearance of Auroral streamers in the north. These appearances continued to increase, but more especially the spreading of the glowing red colour, till the north-western sky was *covered with large patches*, which increased and decreased in size, appeared and disappeared, with a rapidity which was truly surprising; about seven o'clock it became cloudy."

Professor Chevallier says: "Soon after eight o'clock similar phenomena (to those he before described) were observed; but the streamers now rose to a greater height, some attaining even the zenith, and the rose-coloured tinge of the sky was *still more remarkable*." Mr Glaisher takes no notice of any glowing red-coloured patches; but states, that, from "between 7^h 30^m and 9^h 40^m, there were occasional streamers, both *red* and *white*." Whilst at Oxford, at about eight o'clock, and for some time afterwards, the red colour became *less than it had been for the hour and half previous.*

Professor Chevallier says, that "at $8^h\ 29^m$, mean Greenwich time, a faint but sufficiently well-defined corona was formed by the apparent convergence of beams of light to a point about 70° of altitude, and 26° eastward of south." I have seen no notice in any other report of a corona having been seen at this time, and I believe no such appearance was seen at Oxford. No allusion is made to the strange misty appearance of the sky as seen here, although it was visible for some hours, commencing about eight o'clock (the time when the red colour of the sky began to disappear). I have seen no notice of the curious curtain or fringe like lights, as they appeared here at about $9^h\ 43^m$, although I think they were too striking to escape the notice of any observer at the time; nor is any notice taken of the dark arch under the hazy part of the sky. There are discrepancies, also, as regards both time and appearances of the grand auroral phenomenon at about ten o'clock; while the beautiful appearance, as seen at Oxford from $11^h\ 45^m$ to twelve o'clock, is not noticed by Professors Challis and Chevallier; and Mr Glaisher describes a very different phenomenon, as seen at Blackheath; as he says, "The phenomenon at midnight exhibited an appearance as beautiful as any of those that had preceded it. An *arch* appeared extending from the north-west to the south-east; from this arch very bright and flickering pencils of light darted out, both upwards and downwards. At $12^h\ 30^m$ the streams were frequent; the arch now extended from the north by west to the east by north, and at every part of this arch an occasional streamer, with its taper-like form, sprung up; and this appearance continued till after 13^h." Of this arched appearance *I saw nothing*, as after the disappearance of the beautiful fan-like rays which commenced at $11^h\ 45^m$, and ceased at twelve o'clock, Oxford mean time, nothing was to seen here except "a tinge of red on the north-east and western horizon, with an occasional streamer from the north, which continued when I left the scene at half-past twelve o'clock."

These discrepancies are far too great to be accounted for as mere errors of description, and a due consideration of them is of great importance, as regards the subject in question. In the last case, at midnight, at two places not sixty miles apart, with a perfectly cloudless sky, totally dissimilar appearances were seen. Now, had the appearance at Oxford been similar to that at Blackheath, and the height of the arch, as it appeared at each place, been accurately taken, a calculation might have been made from these observations, and the height of the aurora been considered as fairly ascertained; whereas the two arches may have been as totally distinct, and no more to be referred to one point, than the appearances above described; consequently, the result could in no way be depended upon, and I cannot conceive that any two observers, at a distance from each other, can ever be certain that they are looking at the same appearance, or at an appearance in one and the same place.

But the most important point, and one that I believe will fully bear out my opinions, is the difference in the observations of Professor Chevallier at Durham, and Professor Challis at Cambridge, on the position of the centre of the corona, as seen at those places.

Professor Chevallier says, "But the most brilliant spectacle was presented at ten o'clock. At this time the whole of the south-western part of the sky was glowing with rose-coloured light; while bright streams arose from all sides, especially from a little south of west to a little east of north, passing beyond the zenith, and converging in a flickering corona *in the same part of the sky as before*, the bright star Mirach (β Andromedæ) forming now nearly the central point."

Professor Challis says,—"The most remarkable feature of the phenomenon was the distinct convergence of all the streamers towards a single point of the heavens, situated a little to the east of the meridian, and to the south of the zenith. Around this point a corona, or star-like appearance, was formed, the rays of which diverged in every direction from the centre,—leaving a space about the centre free from light, on which I noticed at one time the rapid formation and disappearance of part of a circular luminous ring. It was easy to fix on the central point.

"According to an estimate made conjointly by myself and a friend at 10^h 10^m Cambridge mean time, it preceded the bright star Mirach, or β Andromedæ, 10^m in right ascension, and *had greater north polar distance by two degrees:* consequently, by calculation, its azimuth was 80° 41′ from south towards east, and its altitude 69° 51′. The azimuth appeared not to vary with the diurnal motion of the heavens."

Here, then, are two observations on an auroral appearance, the most distinct and unmistakeable. First at Durham (lat. 54° 46′ 30″) a corona is seen, the centre of which is in a line with the star Mirach. At Cambridge (lat. 52° 13′) about the same time a similar corona is seen, and its position in the heavens distinctly marked out in reference to the same star. Nothing could be more satisfactory for the determination of the height of the aurora, as the places of observation were distant full 2½° the one from the other; the object of observation had been noted carefully, and was not a mere fleeting point; as at Durham a corona had been seen " in the same part of the sky" about an hour and a half previous, and at Cambridge the corona was seen for some time, and its " azimuth appeared not to vary with the diurnal motion of the heavens."

Under these circumstances there can be no doubt, that had the corona been observed at Cambridge to the north of Mirach, these observations would have been taken as sufficient to determine the height of the aurora. But instead of the corona appearing some 60° north of Mirach, as it should have been, had the height of the aurora been 160 miles, and more or less, according to its height, the corona appeared 2° south of that star; thus having very nearly the same altitude as at Durham, and therefore giving the most convincing proof that no dependence can be placed on any observation on the apparent altitude of an aurora, for the purpose of determining its height from the earth.

I intended looking over the various reports on auroræ, given in the Philosophical Transactions, to see how far they coincided with the opinions I now advance; but have only had time to go through Halley's celebrated report on the aurora of March 6, 1716; and although this report is often referred to, to prove the great height of auroræ, yet I believe that it will not only strongly support the opinion that no dependence can be placed on observations on the altitudes of auroræ; but that it also proves in a great degree that the aurora takes place at a very little height, compared with that which has generally been ascribed to it.

It is stated in the report, that "there was very little difference from what appeared in London and Oxford, unless that in the north of England and Scotland the light was somewhat stronger and brighter." Yet this justly celebrated philosopher gives the following hypothesis in explanation of the various appearances reported in the many accounts of this aurora, sent to the Royal Society. After describing the perpendicular beams as caused by the rising of the magnetic fluid, in columns perpendicular to the surface of the earth, and the corona as caused by the beams ascending to such heights "as to emerge out of the shadow of the earth, and to be illustrated by the direct beams of the sun; whence it might come to pass, that the first corona was seen coloured and much brighter than what appeared afterwards in some places, where the sight thereof was more than once repeated, after the sun was gone down much lower under the horizon; hence also it will be easily understood that the corona was not one and the same in all places, but was different in every differing horizon; *exactly after the same manner as the rainbow seen in the same cloud is not the same bow, but different to every eye.*

In another place, he gives strong evidence of the mere local appearance of auroral phenomena; as he says, "the light had now put on a form quite different from all that we have hitherto described, and had fashioned itself into the shape of two laminæ or streaks, lying in a position parallel to the horizon, whose edges were but ill terminated. They extended themselves from the north by east to the north-east, and were each about a degree broad; the undermost about eight or nine degrees high, and the other about four or five degrees over it; *these kept their places for a long time, and made the sky so light, that I believe a man might easily have read an ordinary print by the help thereof.*" Now, although these lights were so different from all that had preceded them, and were so bright, yet, they do not seem to have been seen by any other observer, as farther on he says, " I have thought fit to annex a figure exhibiting the particular appearance of the two laminæ which I saw at London, between 10 and 11 ; more especially, because I do not find, among the many relations I have seen, any one that has taken notice of it."

From these extracts, I think it may be fairly inferred, that on this occasion, (as also during the late aurora), although auroral action was going on simultaneously over a great space, and presented generally similar appearances, yet the same appearances were not in reality seen at different places ; and thus one of the great arguments in support of the opinions which ascribe such great elevation to the aurora, is removed.

This extraordinary aurora was seen over all the north of Europe, from the west of Ireland to the confines of Russia and Poland on the east; as also on the north-west coast of Spain. From this it has been considered that its elevation must have been exceeding great, but I cannot think it proves more than that the auroral action was going on simultaneously over these countries.

And in fact, there is strong evidence to the contrary, as in another article on the subject, (p. 430), there is the following passage : " In our last, we endeavoured to give the public as good an account of the late surprising meteors seen in the heavens on the 6th of March last, as could be gathered from the several relations of very distant spectators, which had come to the Royal Society's notice ; and since then, we can only add thereto, that at Paris, the light was so *inconsiderable*, that it was not regarded."

This fact, that the auroral light was not seen at Paris, tells strongly against the theory of the great elevation of the aurora. But to this evidence, it may be objected that clouds may have prevented the light being seen at Paris. If this had been the case, it surely would have been noticed by Halley, as the subject excited so much interest at the time as to produce a special report at the request of the Royal Society.

There is another instance of an aurora mentioned by Dr Halley, which may also be advanced, *i. e.*, " That of the year

1621, on the 2d of September, seen all over France, and well described by Gassendus in his Physicks, who gives it the name of the Aurora Borealis. This, though little inferior to what we lately saw, and appearing to the northward both of Rouen and Paris, is nowhere said to have been seen in England, over which the light seemed to lie."

From a consideration of the points I have advanced, together with the fact, that the aurora takes place in the frigid regions, about the ordinary height of the clouds, or even at less heights, as proved by the observations of Franklin, Richardson, Parry, &c. I submit that there is no sufficient ground for assuming that the aurora ever takes place above the earth's atmosphere, and I believe it does at times take place in England, at heights very little above the higher regions of the clouds. I again beg to suggest a trial of the experiment I proposed to the British Association, at the Glasgow meeting, *i. e.*, for causing the aurora by raising electric conductors by the aid of balloons, to the height of the clouds in the frigid regions during severe frosts; and as I suggested similar experiments with electrical kites, to Sir John Franklin, previous to his leaving England, I have hopes that some farther light may be thrown on the subject on his return.

G. A. Rowell.

November 22, 1847.

Since writing the foregoing, I have read in the Philosophical Transactions, the paper of the late Dr Dalton on the height of the aurora of March 29, 1826; and I think there are many points in it which tell in favour of my views.

On that evening an auroral arch was seen at Edinburgh, and several intermediate places thence southward to Warrington, on the south border of Lancashire, and it was assumed that the same arch was seen at each place.

Dr Dalton first gives the account of it as seen at Edinburgh, and then the accounts from Jedburgh, Hawick, and Kelso, places about 40 miles south of Edinburgh. These accounts seem to be drawn up with care, but Dr Dalton remarks, "From this it would seem that the arch, instead of appearing low from the last mentioned places, as it must have done if situated only five or even ten miles above the earth's surface, appeared as far to the south of the zenith as at Edinburgh, or rather further."—" Unfortunately the Edinburgh and Hawick observations do not harmonize together; however, those at Jedburgh, a place of nearly the same latitude as Hawick, seem to shew that both the others are wrong, or rather, perhaps, that they had not been contemporary with each other and the rest of the observations. The Hawick altitude is probably too low, and that at Edinburgh considerably too high."

From the seeming impossibility of arriving at any conclusions from accounts with such discrepancies, the Doctor rejects these observations altogether, although, apparently, they were otherwise entitled to full credit, as the situation of the arch is pointed out in reference to certain stars, &c.; and he adopts the observations at Whitehaven and Warrington as the basis of his calculation.

At Whitehaven the altitude seems to have been taken with no more care than at the former places, as it is said that at $8^h\,45^m$ the arch was about 15° south of the zenith. " At $9^h\,8^m$ the arch moved southward."

At Warrington, the method of taking the altitude is very unsatisfactory. Dr Dalton says, his friend, Mr Crossfield, informed him that " he saw the arch about nine o'clock, or between that and ten. At the first glance he took it for the milky way, but soon discovered his mistake. The direction of the arch was from WSW. to ENE., passing to the north of the zenith. The western branch was longer and more brilliant. He saw no northern lights at the time, neither did he apprehend the phenomenon was connected with them. On elevating the pole of a celestial globe till the axis passed through a series of angles with the horizon, I desired him to fix upon an elevation which he judged most nearly to coincide with the elevation of the centre of the luminous arch. On examination, the angle was found to be 61°. I fixed the angle at 70°; this he was almost certain was too high. When it was fixed at 50°, he was still more certain that it was too low."

From these observations, Dr Dalton calculated the arch was 100 miles high, or 8 or 9 miles in width.

Altitudes taken by such means as these, are but very little to be depended upon, and there seems to be no proof that the observations were simultaneous ; as at Whitehaven, it seems to have been taken between $8^h\ 45^m$ and $9^h\ 8^m$, this being the time the arch moved southward ; and at Warrington, the arch was first seen at about nine o'clock, or between that and ten." I therefore submit that, in this case, there is no sufficient evidence that the aurora is at any great elevation, and that the discrepancies in the observations at Edinburgh, Jedburgh, Hawick, &c., shew the local character of such phenomena ; the little dependence which can be placed on observations of such little appearances ; and the probability, that, as regards such phenomena, no observers at a distance from each other, can ever be certain that they see exactly the same appearance, or an appearance in exactly the same place.

In conclusion, I beg that I may not be thought presumptuous in making these remarks on a paper by this revered and eminent philosopher ; and I believe that, were he living, he would have been pleased with any observation, which, by exciting farther investigation, may tend in the least degree to increase our knowledge on this interesting subject.

G. A. Rowell.

December 4, 1847.

On the Aurora Borealis. By G. A. Rowell.

Sir,—The aurora which appeared on the evening of Sunday last (the 24th inst.), was, I believe, by far the grandest and most extraordinary which has occurred for many years—if, indeed, it was ever equalled in these parts. I have seen accounts of its appearance in several parts of England, *i. e.*, London, Brighton, Cambridge, &c., but they all fail in conveying anything like an idea of the magnificent display as seen at Oxford. I therefore beg to submit the following account, as I had the gratification of observing the phenomenon with but slight intermission for upwards of six hours. I fear, however, that my description will fall short of conveying an adequate idea of the grandeur of the scene.

About a quarter past six o'clock I saw a faint tinge of red colour overspreading the north-western horizon, and at the same time a slight appearance of auroral steamers in the north. These appearances continued to increase, but more especially the spreading of the glowing red colour, till the north-western sky was covered with large patches, which increased and decreased in size, appeared and disappeared with a rapidity which was truly surprising. About seven o'clock the sky in those parts became overcast with dark clouds, and rain fell for some time ; after which the patches (which were between a pink and crimson colour) appeared more distinct than before. About eight o'clock these patches gradually disappeared, except on the north-western horizon, where the crimson light continued decreasing at times till almost invisible, when it burst out again with a bright glowing light, sometimes to the height of thirty or forty degrees, having the appearance of the light from a large fire at a distance. At the same time there was an appearance of the red tinge in the north-east, but not so bright as that in the north-west. This coloured patch was some ten or twelve degrees above the horizon, and extended thence towards the zenith, at times ten, twenty, or thirty degrees ; this light decreased gradually till it faded away about half-past eight o'clock. About eight o'clock there arose from the north an ill-defined band of five or six degrees in depth, of a light misty appearance, having somewhat the form of an auroral arch with its centre about midway between the magnetic and the true meridian. It continued to rise gradually till the lower side of the centre of the arch had an elevation of fifteen or eighteen degrees, while it had so increased in width as to rise almost to the pole star ; but the upper part was so ill-defined that it had the appearance of a fine hazy cloud ; so much so that I believe no one would have thought it otherwise, but for the presence of the auroral lights above alluded to, and since at times faint flashes of auroral streamers appeared in the haze, and disappeared again instantaneously. About nine o'clock a bright crimson patch appeared on the horizon, a little north of east, the stars Castor and Pollux being sometimes within the light, and at other times the light being a little farther towards the north. This light, as also that in the north-west, continued till the grand appearance at a quarter to ten o'clock. The hazy appearance in the north had now increased till it had quite the look of a cloud, except that the stars were visible through it ; the dark arch below it had the look of a black cloud, but I am convinced that it was only the clear sky rendered more dark from the contrast with the light above it. About seventeen minutes before ten o'clock there appeared suddenly in the haze singular patches of whitish light, looking as if two curtains or fringes of light were hanging across the heavens, the one above the other, and parallel with the horizon : they were each about five or six degrees in depth, and perhaps ten or twelve degrees long, the lower one being just above the dark arch—this continued for a minute or two, when a scene presented itself so grand that I fear I can only give a very inadequate description of it. Suddenly from the body of light on the eastern horizon, bright crimson columns or streamers flashed up with inconceivable velocity towards a point ten or twelve degrees south of the zenith, while from the hazy cloud in the north, similar columns, but of a yellow light, shot towards the same point south of the zenith, and reaching northward to near the top of the dark arch; and from the west the columns were of such bright crimson and flame colours as to render the scene in that direction truly magnificent; in the part of the sky to which the several columns converged, there appeared a sort of irregular circular space of four or five degrees diameter, into which the several columns seemed to be pouring volumes of fiery smoke, which appeared to wave about similar to the motion of flames in an oven, or under the action of winds blowing from all and every direction, the whole having the appearance of a half canopy or tent spreading over the northern portion of the heavens. During this appearance flashes of light were continually passing up the columns, as if a film of steam was projected up them with the greatest velocity, or as if the whole canopy had been shaken by the wind, and the light was reflected and glancing off from its surface.

This sublime spectacle continued for ten or fifteen minutes, when it gradually faded or rather crumbled away, disappearing in a very singular manner about ten o'clock. From this time I observed nothing particularly striking, except an occasional tinge of crimson in the north-west and north-east, and a few flashes of streamers from the north through the hazy part of the sky, till at about a quarter past eleven o'clock, when very bright crimson streamers flashed from the eastern horizon as before, which soon faded into a dull crimson haze. About the same time streamers of a very singular appearance began to flash from the north towards the south; they seemed like columns of light smoke or steam darting with the velocity of lightning along the sky, having something the appearance of water thrown with great violence from a syringe. About a quarter to twelve o'clock columns of a more regular form began to appear from the north-east to the north-west, and in a few seconds formed one of the most beautiful scenes that I believe was ever witnessed; from the eastern horizon, a few degrees north of Castor and Pollux, bright crimson columns arose to within six or seven degrees of the zenith, or rather as before to a point ten or twelve degrees to the south of it; from these crimson columns others of a bright whitish light spread over the whole of the northern part of the sky to north-west, where other crimson columns formed (the star α Aquilæ being a little to the south of them), the whole having the form of a large fan of light spread over the northern portion of the heavens; but the rays did not meet in the centre, but terminated in points about six degrees from it. I may perhaps describe it better, as representing the tail of a bird spreading over the northern sky to above twenty or thirty degrees from the northern horizon, and spreading on each side till it meets the horizon at the points described, the features being of a whitish colour, except the outer ones, which were crimson.

The scene at this time was beautiful in the extreme, the dark arch on the northern horizon contrasting strongly with the bright appearance above it; while to the south of the zenith the sky was perfectly cloudless, the full moon (with her attendant Mars) shone brightly; and as she was at the time very nearly on the meridian, and only a few degrees south of the point to which the auroral rays converged, it seemed as if the rays of light emanated from the moon (but this only owing to her peculiar position at the time); the planet Jupiter shone brilliantly in the east, together with the stars of Orion, &c.; and thus was formed one of the most delightful scenes, one indeed that can never be forgotten by those who had the pleasure of witnessing it. This appearance continued with slight alteration till about twelve o'clock, after which there continued a tinge of red on the north-east and western horizon, with an occasional streamer from the north, which continued when I left the scene at half-past twelve o'clock.

It may perhaps be worthy of notice that patches of crimson light similar to those seen in the earlier part of the evening, were seen during an occulation of Mars some ten or twelve years since, and that an occulation of Mars took place on the 24th also.—I am, yours, &c.,

G. A. Rowell.

October 28, 1847.

Biographical Sketch of the celebrated Alexander Brongniart.*

M. Brongniart was born at Paris in 1770. His father was justly celebrated for his attainments in the fine arts. His mind developed itself in the midst of that brilliant society, belonging to the end of the eighteenth century, which his father was accustomed to draw around him. He then derived from conversations with Franklin the germ of that mild and practical philosophy which he never abandoned; from those of Lavoisier, his earliest notions of chemistry, which formed one of the foundations of his scientific career. He gave early indications of that clearness of elocution which

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* At the funeral of M. Alexander Brongniart, which took place on Saturday 9th October, M. Elie de Beaumont gave an address, from which the above is an extract.

formed one of his merits as a professor; and it is related that Lavoisier himself took pleasure in listening to a lecture on chemistry delivered by Brongniart, when he was scarcely fifteen years of age. He soon concluded his earliest scientific studies at the School of Mines in Paris, which Louis XVI. had founded, and where Sage taught him mineralogy. At twenty years of age, in 1790, he undertook a scientific journey. He visited England, where the mines and picturesque scenery of Derbyshire made a strong impression on his mind, and from whence he brought back the elements of a memoir on the art of enamelling. His uncle, who was chemical demonstrator in the Jardin des Plantes, took him to be an assistant, and initiated him in the practice of chemistry. He likewise studied in the Ecole-de-Medecine, where he was thrice enrolled, and when the first requisition called every Frenchman to the frontier, he was connected with the army of the Pyrenees, in the capacity of apothecary. A stay of fifteen months among these mountains gave him the opportunity of studying a rich and varied field of nature, as a zoologist and botanist. He likewise made geological observations which, at a later period, took their place in the science, and which he often took pleasure in recalling; but he there encountered dangers which his youth did not suspect, and he was imprisoned under suspicion of having favoured the escape of the skilful naturalist Broussonnet, who avoided certain death by fleeing by the breach of Rolland. Restored to liberty after the 9th thermidor, he returned to Paris, where, on the recommendation of Fourcroy and Coquebert de Montbret, then occupied with statistical mineralogy, he was attached to the agency of mines, in the capacity of mining engineer. Soon after he was called to the Professorship of Natural History in the central school of Quatre-Nations; he became a contributor to the best scientific collections of the period; and a little after the 18th brumaire, in 1800, he was nominated director of the Porcelain manufactory of Sévres, on the recommendation of Berthollet.

When the imperial University was organised, M. Brongniart was entrusted with the composition of an elementary treatise on mineralogy. This work, which appeared in 1807, was one of the best, and, in particular, one of the clearest and most practical, which had been published on this science, hitherto so difficult of access. There was remarked in it, what we remark in it still, a peculiar originality of exposition, and a penetrating clearness, worthy of forming a model to others desirous of rendering the sciences level to the capacity of youth. This work was of important service, and became the text-book, assiduously improved, of the instructions which M. Brongniart for a long time gave to the Faculty of Sciences, as assistant to M. Haüy, and which he continued in the Museum of Natural History, when he was called to replace this illustrious master in that establishment.

But M. Brongniart did not confine himself to mineralogy. His works exhibit the same variety as his studies. He long continued to occupy himself with zoology, in which his first undertakings have not been forgotten. It is to him that we are indebted for the division of reptiles into four orders; and the naturalists of the whole world have adopted after him, according to the example of Cuvier, the names of *Saurians*, *Batrachians*, *Chelonians*, and *Ophidians*—names which now appear so natural, that we often repeat them without remembering who was their author. At a later period he likewise created the name *Trilobites*, and fixed the basis of classification for these singular crustacea, strangers to all modern creations, in a learned memoir which has been the starting point for all the works relating to this immense family.

Independently of the honour he derived from them, M. Brongniart owed perhaps to his zoological labours one of the happinesses of his life, his intimate connection with the illustrious author of the Regnè Animal and of comparative anatomy. When M. Cuvier was brought to Paris, M. Brongniart appreciated from the first the high caste of his intellect. He soon became one of his most faithful friends and most sincere admirers; and this noble feeling continued, in the greatest intensity, to the last day of his life. But he did not confine himself to admiration, and he was enabled to contribute, in his own proper sphere, to one of his friend's greatest works.

The masters of science have declared, that Cuvier's discoveries respecting the fossil bones of the chalk formations of Montmartre, are the most original of all those which will preserve his name to future ages. These discoveries could not be placed in their proper category; it was even impossible to deduce the resulting principles from them, until the formations in the neighbourhhod of Paris should be examined mineralogically, and classed geologically in the order of their position. The eminently judicious mind of Cuvier felt the need of being assisted in carrying out, in the most complete manner, researches having such a special object. M. Brongniart had travelled in 1808, in Auvergne, where he had pointed out formations as being made in fresh water, inasmuch as they contained only river shells in a fossil state. This was an entirely new application of zoology to the study of mineral deposits. M. Cuvier at once perceived the fellow-labourer which nature had destined for him, not as another Daubenton, (in itself a connection so glorious), but as a mind of similar complexion and wonderful originality, adapted to his own. Already prepared for the task by his previous studies of the Montmartre gypsum and Champigny limestone, himself the chief of the school, and seconded in certain details by pupils, then young, and since become celebrated professors, M. Beudant, M. Constant Prevost, and the younger M. Desmarest, M. Brongniart presented to the first class of the Institute, in the month of April 1810, in concert with M. Cuvier, the *Essay on the Mineralogical Geography of the Neighbourhood of Paris*, which first appeared in the *Journal des Mines*, and soon became so celebrated. Reprinted in 1811, with additional development, this work, in which the first rules for the application of zoological determinations, for the purpose of characterising formations are laid down, and which has ever since continued to be the classical type of works of the same kind, opened to M. Brongniart, in 1815, the doors of the Academy of Sciences. He replaced in that institution the indefatigable explorer of the volcanoes of Auvergne, Desmarest, whom he surpassed in reputation.

M. Brongniart never knew repose. His admission to the Academy redoubled his activity. Animated with an enthusiasm, as judicious as fruitful, for the vast field which he had so sagaciously entered, he became in a few years, the legislator in this branch of geology, then so new and important. He settled the laws of it, by examples which, in such a case, are the most solid of all precepts. Like that Greek philosopher, in whose presence motion was denied, M. Brongniart advanced in this career with an intelligent and indefatigable ardour, and every one of his steps has been an important discovery. A conqueror in a new field, M. Brongniart set out in 1817 for Switzerland, the Alps, and Italy, accompanied by his son, and one of his most skilful pupils, M. Bertrand Geslin.

In these countries, where Saussure had already immortalized himself, he fixed, in the most unexpected manner, landmarks which are still standing, and which no longer give place but to discussions in detail, without which no work on natural history can be perfect. Who has not been struck with the boldness, as fortunate as it was surprising, with which M. Brongniart associated the black limestones of the mountain of Fis, in Saxony, with our chalk formations of the north of France! In 1822, all the results of this kind which he had obtained, were inserted in a second edition of the *Geological Description of the Neighbourhood of Paris*, which thus became more especially the monument of his genius.

But he did not limit himself to the modern formations, the particular object of this great work. Later, in 1824, M. Brongniart visited Norway and Sweden with the same view. He was warmly received by M. Berzelius, who wished to act as his guide and interpreter in a country whose language was unknown to him. He there laid down the first foundations of a classification of the most ancient fossiliferous formations. It was likewise in this voyage to Scandinavia, that he united the elements of a memoir on erratic blocks, which happily associated his name with those of the Saussures and De Buches, in the study of a phenomenon on which the extent of the revolutions of the globe are inscribed in the most striking characters.

I ought also to speak to you of his remarkably original memoir on the Ophiolithes of the Apennines, his clear and ingenious views on volcanoes, and Vesuvius in particular.

But you do not expect of me, gentlemen, that I should remind you, in this short sketch, of all the treasures with which the labours of sixty years have enriched the sciences.

M. Brongniart by no means confined himself to a single branch. Neither did he limit himself to theoretical speculations, The cares, labours, and investigations which occupied him for forty years, as the Director of the Royal Manufactory of Porcelain at Sévres, would have worthily filled up the life of an ordinary man of science. He undertook numerous journeys, in order to become acquainted with the great manufactories of the same kind in other parts of Europe, and all the sources from which they derive their first materials ; and thus obtained the elements of a beautiful geological and chemical memoir on the Kaolins, which lately appeared. Faithful to his earliest researches on the art of enamelling, he revived at Sévres the almost lost art of painting on glass, the magnificent results of which we have all had occasion to admire.

M. Brongniart, at nineteen years of age, was one of the founders of the Societé Philomatique—a society as scientific as unpretending, whose device is *Science et Amitie*. It was the centre of many useful communications, and, at the period of proscription for all of a higher class, kept alive the sacred flame of science.*

On the Changes of the Vegetable Kingdom in the different Geological Epochs. By M. ADOLPHE BRONGNIART.

The changes which have taken place in the nature of living beings, since their first appearance on the globe till the period when the surface of the earth, having assumed its present form, has been covered by the creation which now occupies it, constitute one of the most interesting departments of geology : it is the history of life and its metamorphoses.

The progress of modern geology presents to us the surface

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* From L'Institut, No. 719, p. 336.

of the globe becoming renewed many times since the period when life first appeared upon it, under the influence of Creative Power. At each of these modifications—every time that a great bed of mineral matter covered a portion of the earth's surface, or a shaking of the crust of the globe wrinkled this surface, and produced new chains of mountains, the living beings which inhabited our earth, destroyed and buried in these sedimentary deposits, were replaced by a new creation more or less different from the preceding.

It would be a difficult task at this moment to fix precisely the number of these successive creations of animals and vegetables; but science is every day leading us nearer to this result, although it requires more detailed facts to enable us to reach it.

At certain epochs, however, great changes in the physical state of our planet have been followed by modifications equally great in the nature of the beings which inhabit it.

These are the very decided changes which alone deserve our attention in the present instance; for, on the one hand, they shew us each of the two organic kingdoms passing through varied forms, of which the different degrees are of great interest, owing to the remarkable order in which they succeed each other; and, on the other, the nature of the beings which correspond to each of these great geological periods, may afford us most valuable indications respecting the physical state of the earth, and its climate, at these different epochs, illustrative of the history of the formation of our globe.

From the most remote historical times, the vegetables inhabiting our globe have undergone no change. This is proved by the comparison of grains and plants preserved in the tombs of Egypt, with those which now grow in that country.

On the contrary, the plants of the latest geological periods, —those which occupied the earth before the last revolution of its surface, and whose remains are enclosed in the deposits named tertiary formations,—differ very considerably from such as now grow in these same places. They are, in general, species no longer existing in a living state, and their differences, relatively to the plants now living on the same ground, are so much greater as they occur in the most ancient beds of these tertiary formations. The most recent indicate a climate differing little from that of temperate Europe; the most ancient announce a warmer climate than now occurs in that region.

But in all these beds, which are very recent when compared with the other parts of the crust of the globe, we find vegetation, as a whole, agreeing in all its principal features with the mass of the vegetable kingdom which still inhabits the surface of the earth; there are the same classes, the same natural families, often the same genera. The general characters of this extinct vegetation are the same as those of the existing vegetation, and we might suppose ourselves only transported to another quarter of the globe. Viewed as a whole they are the same; the details only are different.

But if, on the contrary, we descend more deeply into the layers composing the earth's crust, and go back to the more ancient periods of the creation; if we consider the vegetables preserved in the formations named secondary, which have preceded those of which we have spoken by many ages, we shall find the vegetable kingdom reduced to a much less considerable number of those natural groups which we name families or classes.

This variety of form and aspect, which gives such a charm to the existing vegetation, did not then exist; and, to characterise in a word the vegetable kingdom of those remote periods, we may say that the plants composing it, much less varied and numerous than those now covering our ground, were all deprived of what constitutes their greatest ornament, namely, those flowers with brilliant envelopes which belong to almost all the plants of our period. All the vegetables of the first geological periods were in fact analogous to our firs and ferns, whose habit and elegant foliage form all their beauty.

In these ancient times of geological history, we may farther distinguish two great periods; the one nearest our own times, during which terrestrial vegetation, almost entirely limited to three families, the ferns, coniferæ, and cycades, presented only species so far analogous in their most essential characters to those now existing, that they may be easily classified in the natural families I have just named; the other, more ancient, to which the vegetables belong whose remains have produced great deposits of coal, and numerous remains of which accompany beds of this combustible. The latter recede much more widely from actually living forms, enter with more difficulty into known families, evidently constitute other families altogether distinct from those of our actual creation, families whose existence has not been prolonged beyond this first geological period.

The singular organisation and great dimensions of these first inhabitants of our soil, have long thrown much obscurity over the great classes of the existing vegetable kingdom. Every day, however, the study of them is advancing, and now we can no longer doubt that these gigantic vegetables, so remarkable by their extraordinary forms and by their structure, constitute special families, allied, however, to the ferns and coniferæ; (that is to say, belonging to the great divisions of vascular cryptogams, and gymnospermous phanerogams.)

In conjunction with many true ferns, often arborescent. and with some coniferæ, very different from those of our climate, these vegetables must have formed vast forests growing on a turfy soil, produced by their detritus, and to which our coal owes its origin.

Thus, briefly to recapitulate; during the earliest periods of the creation of living beings, the vegetable kingdom was composed only of plants belonging to the two classes of that kingdom distinguished by the simplest structure. These plants had then special forms, were of considerable dimensions, and the greater part constituted families now extinct.

At a later period, these two great classes still continued to exist alone on the earth, but their forms approached more to those which they present in the present vegetation; the families peculiar to the most ancient epochs were already destroyed, and the numerous and varied families which were to appear in the tertiary epoch did not yet exist.

Lastly, during this latter period, vegetation assumes characters analogous to those it now presents. Those more perfect vegetables, known by the name of angiospermous phanerogams, appeared in great numbers, and the vegetable kingdom is not distinguishable from that now existing but by characters of detail, or by differences analagous to those which diversities of climate still produce on the earth.

If we now compare the vegetables of the families which, like the ferns and coniferæ, have been perpetuated during all the geological periods, from the most ancient up to the present, we perceive that such as belong to the most remote creations, approach particularly plants of these same families which now inhabit regions of the earth having a climate very different from our own; and that such, on the contrary, as we meet with in the most recent beds, become so much the more analogous to the species which still grow in these same countries, as the geological period to which they belong approaches nearer our own.

Everything, therefore, proves, on the one hand, that the different vegetable creations which have succeeded each other on the globe have become more and more perfect; on the other hand, that the climate of the surface of the earth is greatly modified since the earlier times of the creation of living beings up to the commencement of the present epoch. *

Observations on the Relative Position of the Formations of the Western Swiss Alps, and of the Alps of Savoy. By Professor Favre.

If we take a rapid glance at the formations of the Western Swiss Alps and the Alps of Savoy, with the view more especially of determining the relations of position existing between them, we shall find that these mountains are composed in the following manner:—

1. *Crystallised formations*, formed of rocks of a very varied character, very generally known, and on which we need not make any further remarks.

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* From L'Institut, No. 714, p. 289.

2. *Metamorphic rocks.* These are gneiss, mica-schists, schistose protogines, &c. These rocks rest, in an irregular manner, on the crystallised formation.

3. *Pudding-stone, or the Valorsine system,* in large strata, often containing anthracite. In general, this system is formed at its upper part by schists, sandstones, or very argillaceous limestones, exhibiting many impressions of ferns. Sometimes these latter rocks are wanting, because, in great upheavings, the argillaceous rocks are more easily compressed than the others, and disappear.

I have not hitherto observed in Savoy any discordance between this anthracitic system and the metamorphic rocks.*

4. Above the Valorsine system come the limestones, and the more or less argillaceous schists of the *jurassic formation,* terminated at the lower part by a bed of *Cargneule,* or cellular magnesian limestone. This jurassic formation has a stratification not conformable with that of the Valorsine system; and may be seen on the right bank of the Rhone, between Bex and Martigny. The valley of the Rhone there forms an immense section, very nearly perpendicular to the direction of the formations of the Alps. We there observe that the crystalline and metamorphic formations form two parallel chains, which run under the secondary formations of the northern chain of the Valais.

The Valorsine system is compressed between the two chains, and covers them only in part, while the cellular magnesian limestone, surmounted by the jurassic formations, envelop them entirely; and it may be said that these formations, notwithstanding the accidents to which they have been subject, form a kind of vault, which extends from the baths of Lavey to Saillon, in the Valais, and rises in the mass of mountains crowned by the Dent de Morcles.

The stratification of the jurassic formations, moreover, is transgressive in relation to that of the Valorsine system.

5. *The cretaceous formation* rests on the jurassic formation. It is divided in the following manner:—

* This discordance, however, has been pointed out in the Alps of Dauphiny. See *Bulletin de la Société Géologique de France;* meeting at Grenoble, 1840, XI., and my *Memoir on the Anthracites of the Alps.*

a. Neocomian, which is characterised by the Holaster complanatus, the Gryphees, and Crioceras. The last mentioned fossils have been found only in erratic blocks.

b. First zone of the rudistes, or limestone with Hippurites or Chama ammonia; nummulites are never observed. This bed is the one which has most influence on the relief of the surface in the cretaceous districts of the Alps. It forms, in general, dentated crests, very arid, and of great elevation.

c. Albian formation, gault or green sandstones, very rich in fossils, which, in certain localities, seems to alternate with beds of limestone.

d. M. Studer has described a formation, occurring in the centre of Switzerland, under the name of *Seeven limestone;* but this formation does not exist either among the Western Alps of Switzerland, or in those of Savoy. At Diablerets, for example, we may place the hand in such a manner, that one of its extremities rests on the green sandstone, and the other on the nummulites limestone: it often even happens that the fossils of these two beds are mingled. This observation, made in many other localities, is a good proof of the non-existence of the Seeven limestone in these regions.

All these stages of the cretaceous formation are conformable with each other, but their stratification is not conformable with the jurassic formation. The latter, indeed, have been subject to dislocations before the deposition of the cretaceous formation; these dislocations are indicated by great contortions.

These are seen in the bottom of some of those deep valleys, which permit us to obtain a view of the interior structure of mountains. These contortions, or rather this contortion, for it is a single accident which we observe in different localities, is placed on a line very nearly straight and parallel with the Alps. I have observed it for a length of about 13 leagues: the most northern point is the Dent de Daily, above the baths of Lavey (on the right bank of the Rhone). These contorted beds pass below the great mass of the Dent du Midi, and re-appear on the south-east, under the glaciers of Mont Ruan, at the bottom of the Combe de Sixt.

They are likewise found in the lower part of the mountains of Fiz, on the side of Sixt, at a place called *Faucilles du Chantet.*

This contortion runs across below the mountains of Fiz, and is seen at the celebrated waterfall of the Arpenaz, on the banks of the Arve. Lastly, a fifth locality, where the same observation may be repeated, is found near Giétaz, in the valley of Mégève.

In all these localities, the contortion of the beds is situated in the jurassic formations, while the cretaceous formation covers these dislocations without having shared in them.

6. *The nummulites limestone*, which participates in all the dislocations which have given relief to the cretaceous grounds. Besides the characters indicated by M. Leymerie for this formation in the Corbières,* it furnishes us, among the Alps, with the opportunity of making two important observations.

We observe, in the first place, that this formation contains a bed of coal so considerable as to be wrought at some points. These localities, advancing from NE. to SW., are the chain of Titlis ;† at the extremity of the cantons of Berne and Unterwalden, the heights of Beatenberg and Habkeren,‡ to the north of the Lake of Thun, and the Mittaghorn, to the south of Frutigen ; these localities are indicated by M. Studer. There are others besides, which I have visited myself, namely, —the celebrated bed of Diablarets, where the coal is associated with Cerithium diaboli and other fossils. The mine of Pernant, not far from Arrache, on the right bank of the Arve ; this mine was described by M. Necker in 1826.§ I shall only add to his observations, that the bed of fossils is in contact, and below the true nummulitic limestone, and forms part of that formation. The coal-mine of Petit-Bornant near Bonnevilles, and that of Entrevergne on the southern shores of the lake of Annecy.‖ These eight localities running nearly in a line

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* Memoires de la Société Geolog. de France : Archives, 1846, t. i., p. 107.

† Studer, Mem. de la Soc. Geolog. de France, t. iii., p. 394. This is merely a carburetted schist.

‡ Studer, *Ibid.* iii., 388. The coal has been mined these 40 years.

§ Necker, Bibl. Univ. de Geneve, Sc. et Arts, xxxiii., 90.

‖ Bulletin de la Société Geolog. de France. Extraordinary meeting at Chambery, 1844 ; t. i., p. 601, &c.

parallel with the Alps, shew that, at the period of the deposition of the nummulitic limestone, a carboniferous formation was made of great extent, which has been subjected to inundations and immense dislocations.

A second character of the nummulitic formation, of greater theoretical importance, is the following:—*this formation is independent, in the mode of its arrangement, of the cretaceous formation which is inferior to it.* This important fact merits some details.

The nummulitic beds, as I have stated, lie above the albian formation, and the first zone of the rudistes. But at Voirons, near Geneva, the nummulitic rocks, under the form of grès,* rest on a thin bed of jurassic limestone, the exact age of which is undetermined, but which lies above a kind of limestone, which is unquestionably the Oxford limestone.

A similar disagreement has been pointed out by M. Chamousset in the chain of Nivolet near Aix, where the nummulitic rocks rest on a coralline limestone. He states that he has also observed them in the Valley of Thônes, in contact with a black Oxford limestone, and that *M. Sismonda has seen them among the maritime Alps, resting sometimes on the lower chalk, sometimes on the Neocomian, sometimes on jurassic beds, which he presumes to consist of lias.*† On the other hand, Professor Studer has found the nummulitic formation, in the canton of Appenzell, resting on the Seeven limestone, which, as I have said, is superior to the albian formation; in the neighbourhood of the lake of Thun, resting on rudistes limestone, and at Mont-Faudon, near Gap, on the Oxford clay.

All these instances evidently prove, therefore, the independence of the nummulitic formation of the Alps.

7. *The Flysch or Macigno*, is formed by fine micaceous or talcose sandstone, by coarse quartzy sandstone, by schists or calcareous breccia, which always present a most remarkable

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* Many years since, M. Boué pointed out the nummulites in these sandstones at Voirons. *Guide du Voyageur Geologique*, iii. 395. I have made the same observation. The grès of Valerette at the foot of the Dent du Midi, near Saint-Maurice in the Valais, likewise contains nummulites.

† *Bulletin de la Soc. Geolog. de France*, Second Series, i. 621.

resemblance to lias rocks. Nearly for a third of its thickness, this formation contains *cargnules* and gypsum in beds. I never found nummulites in the macigno, but in some localities, the remains of fishes are abundant: in it these are, scales, fins, and small jaws. M. Agassiz regards some of these fragments as characterising the fishes of the cretaceous epoch.*

This formation seems to be identical with the Italian macigno, although M. Pilla in his new observations, on the hetrurian formation, places it below the nummulitic limestone.† Like him, I have ascertained its independence. Indeed, while travelling from Saint-Jeoire to Samoens in Savoy, we perceive that this macigno or flysch runs in layers very nearly horizontal, although undulated, along the right bank of the Giffre. These layers rest, to the north-west, on the jurassic beds, and to the south-east, on the nummulitic limestone, which is itself placed on the Chama ammonia limestone. This observation proves that the macigno is independent of the nummulitic limestone. Consequently, the nummulitic limestone and the macigno are both independent of the cretaceous formations, and independent of each other.

The point of Marcely, which rises to about 1280 metres above the little town of Tanninge, is wholly formed of the nearly horizontal layers of which I have just spoken. This number gives an approximate idea of the thickness of the flysch formation. Now, as it has been subjected to all the dislocations which have formed the relief in the formations of h e Alps, it is probable that, in order to get the true height to which many of the calcareous chains of the Alps arose in ancient times, we ought to add to the actual height of the needles and cones with which they are covered, the thickness of the formations which have been subjected to the same modifications. Thus, it is necessary to add to the enormous height of the Pointe Percie,‡ formed by the Chama ammonia limestone, the thickness of the nummulitic formation and that of the macigno. And to the Buet, the peak of which is ju-

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* *Bulletin de la Soc. Geolog. de France*, 1844, i., 626.

† Mém. de la Soc. Geol. de France, 1846, ii. 163, and Archives, 1846, i. 107.

‡ From *Supplement a la Bib. Univ. de Geneve*, No. xviii. p. 120.

rassic, we must add the cretaceous and nummulitic formations, as well as 1300 metres of macigno.

The macigno rocks being somewhat friable, a part must have fallen down at the time of projection ; but it is probable that at some points they have continued unimpaired, and that it is only by degrees, by the effects of denudation and falling down, that certain aiguilles have been lowered to the still considerable height which they now occupy.*

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* This elevated summit is situate at the end of the valley of the Reposoir, and has never been measured. See Saussure, *Voyages*, § 285 and 1977.

NOTE.—*Glance at the Geology of Switzerland*, Extract of a Discourse pronounced at the Jubilee of the Society of Natural History of Zurich, on the 30th November 1846, by M. Arnold Escher de la Linth.—M. Escher, after referring to the works of some Swiss Naturalists, such as Scheuchzer, Saussure, Ebel, Charpentier, Studer, &c., explains the geological phenomena of the Alps. He first adverts to the distribution of the two great masses of mountains, as pointed out by M. Studer; then the fan-like structure of the central chains, the metamorphism, age, and dislocation of the deposits of the Alps, the geographical limits of the formations, their relative position, and the conclusions which may be drawn from the geological history of this country. According to the author, there does not exist in it any formation more ancient than the *lias ;* on it all the formations even to the upper chalk, rest with a conformable stratification. No dislocation, therefore, took place during the whole time these immense deposits were forming; but there was a convulsion between the deposition of the *flysch* (at the end of the cretaceous period), and the *molasse.* It is impossible to explain otherwise the absence of molasse among the Alps. It was at this period that the metamorphic action was exerted, and that many of the sedimentary rocks became crystalline. But after the molasse period, during which the Rhinoceros, Mastodon, Stag, &c., lived, another revolution took place, the principal effects of which were the formation of the basins of lakes, and the opening of the transverse valleys of the Reuss, Linth, &c., valleys which commence in the centre of the chain of the Alps, and are continued in those districts where the ground is formed by molasse. It is at a later period that the erratic formation was spread abroad, the transportation of which M. Escher ascribes to the glaciers.—(*Bib. Univ. de Geneve, May* 1847, p. 418.)

A Description of the Glaciers of the Pindur and Kuphinee Rivers in the Kumaon-Himalaya. By Lieut. R. STRACHEY, Bengal Engineers.

The existence of glaciers in the Himalayas being apparently still considered a matter of doubt by the natural philosophers of Europe, I have thought that some account of two most decided glaciers, which I have just visited (May 1847), in these mountains, in about lat. 30° 20′, may not be uninteresting.

As there is probably nothing specially worthy of note in these individual glaciers, I wish to explain, that, my object being to shew that these phenomena exist in the Himalaya, under forms apparently identical with those observed in the Alps, it has been necessary that I should enter into details, which, under other circumstances, would have been superfluous. As these are the first glaciers that I have ever seen, it is right to add, that I am only acquainted with those of the Alps through the medium of Professor Forbes's accounts; and that, as I lay no claim to originality, I have not scrupled to adopt freely the ideas, and perhaps expressions, of a person so infinitely better acquainted with these phenomena than I can be. To guard against mistakes, I would also mention, that the glaciers were selected for examination only on account of their accessibility, and that, consequently, no inferences should be drawn from them of the general extent of glaciers in the Himalaya.

The Pindur River is the most easterly tributary of the Bhagiruttee, or that stream of the Ganges that issues into the plains of India at Hurdwar. It rises from the south side of one of the great snowy ranges of the Himalaya which contains the cluster of peaks of which Nunda Devee* is the

* The heights of these peaks are as follow :—

No. 10.	15,805	English feet.
11.	20,758	„
12.	23,531	„
13.	22,385	„
14.	25,741	„
15.	22,491	„

—*Vide Asiatic Researches*, vol. xiii., p. 306.

"*Nunda Devee*" is the "*Jowahir*" of the maps. "Jowahir," or more correctly centre. At the head of the Pindur is one of the glaciers I am about to describe: the other gives rise to the Kuphinee, the first considerable affluent of the Pindur.

The Pindur and Kuphinee, rising on opposite sides of the peak called Nunda Kot, unite about 7 miles south of it. A small tolerably level space between them, close to their confluence, is called Diwálee. The lower end of the glacier of the Pindur is about 8 miles, and that of the glacier of the Kuphinee about 6 miles above this place.

The valley of the Pindur, at the termination of the glacier, is about a mile across between the precipitous mountains that bound it. From the foot of the rocks on either side its bottom slopes inward with a moderate inclination, leaving in the middle a hollow about 300 yards wide and 250 feet deep, with very steep banks, at the bottom of which flows the river. This comparatively level space, between the central hollow in which the river runs and the precipitous sides of the valley, its surface running nearly parallel with the present bed of the river, but from 200 to 300 feet above it, can be distinctly seen for a mile or more below the end of the glacier. The plateau itself, as well as the steep banks between it and the bed of the river, are considerably cut up by water-courses running across them from the sides of the valley, but everywhere they have an almost perfectly rounded outline.

The whole of the bottom of the valley is covered with grass, or those species of plants that grow in these elevated regions, excepting where beds of snow, rocks, or the debris of the mountains interrupt the vegetation.

The glacier occupies about two-thirds of the whole breadth of the head of this valley, leaving between itself and the cliffs on the east an open grassy slope, which extends long the foot of the moraine for upwards of a mile and a half above the

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"Jwar" or "Joohar," is the name of a district (Purgunnah) which consists of the upper part of the valley of the Goree River. Nunda Devee is on the boundary of this district, and has been erroneously named after it in many maps, the word "Joohar" being never applied to designate this *particular peak*, though the portion of the range in which it is has undoubtedly been called the *Mountains of Joohar*.

source of the river, and which seems to be a continuation of the plateau I before mentioned.

The first appearance is remarkable: it seems to be a vast rounded mass of rocks and ground, utterly devoid of any sign of vegetation, standing up out of a grassy valley. From the foot of its nearer extremity, the river, even here unfordable, rushes in a turbid torrent out of a sort of cave, the top of which, when I saw it, was but a few feet above the surface of the water. The end immediately over the source of the river is very steep, and of a dull black colour. It is considerably fissured, the rents appearing to arise from the lower parts tearing themselves from the upper by their own weight. On a closer examination, this abrupt end proves to be a surface of ice, covered with sand and gravel, and curiously striped by the channel made by the water that runs down it as it melts. Behind this, the glacier rises less steeply, like a bare gravel hill, to its full height, which is probably about 500 feet above the water of the river, when it leaves the cave; in some places, however, are seen great fissures both vertical and horizontal, the latter evidently made by the separation of regularly stratified layers. The last thing that might be expected of such a dismal coloured and monotonously rounded hill is, that it should be composed within of the purest ice.

The cliffs that form the immediate bounds of the valley where the glacier lies are of no great height; but the mountains of which they are the foot, rise many thousand feet above them, though with much monotony of appearance. Many grassy slopes are still seen considerably above the glacier; but bare rock and snow much predominate, and are soon left in sole possession of these inhospitable regions. Two peaks* which rise, one to the north-east and the other to the north-

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* The peak on the north-west is the most easterly of the three smaller peaks which are seen from Almorah, below Nunda Devee. That on the north-east is the point at the end of the range that descends from Nunda Kot to the north, and appears on its left from Almorah. Between these peaks is the pass called after Mr Traill, over which he went into Joohar, or the valley of the Goree. It is, perhaps, rather gratuitous to call this passage a pass, as no one has gone over it since, and certainly never will go, unless from curiosity. To the right of the north-east peak is another depression in the range, over which, I was told, Mr Traill attempted to go, but failed.

west of the valley, probably to a height of 20,000 feet above the sea, are fine objects in themselves, and the frozen snow on their summits shines gloriously in the sun; but they are not sufficient to prevent the general impression from the scene being one of disagreeable monotony, and of desolation complete indeed, but without sublimity.

The glacier is formed by the meeting of two ice-streams, from gorges, one coming from the north-west and the other nearly from the east, which meet about two miles above the source of the river.

The feeder from the north-west is larger than that from the east, and its surface is at a considerably higher level for some hundred yards below their first junction. It descends with a great inclination, entirely filling the gorge down which it comes, in what Professor Forbes aptly terms a cascade of ice. It assumes the general appearance of a confused mass of irregular steps, which are again broken up transversely into peaks of every shape.

The feeder from the east is formed by the union of two smaller glaciers, one coming from the north-east, the other from the south-east: the latter is the larger of the two, and descends in ice-cliffs to some little distance below the rocky point which intersected my view of its upper parts. The north-east tributary is not so steep, its surface, as far as I could see, being continuous, excepting immediately at its union with the other, where it seems to be a good deal broken up. I did not go to any of these glaciers, and describe them as they appeared from the upper parts of the united glacier.

Another small tributary glacier also falls into the main one from the north-west. Its inclination is very great, but it perfectly maintains its continuity of structure to the bottom.

The lateral moraine of the west side of the northern branch of the glacier shews itself as a black band along the edge of the ice, which, in other parts of the fall, is quite white. The moraine is small at one point; at another, it very rapidly increases, and in its lower parts is a chaos of desolation, such as I never saw before. This great addition to the size of the moraine is owing to the quantity of debris brought down by the small glacier, over the lower parts of which stones were constantly rolling on to the upper end of the moraine during the whole time we were near it. We were thus here enabled to see the actual formation of a moraine. The ice below the junction of this tributary with the main glacier being much broken up by crevasses; rocks and gravel, from the moraines on the two sides of the tributary, are scattered over the space between them, and the moraines, at first sight, appear to lose their distinct form; but although there is no clear ice between the moraine that originates on the east of the tributary and the west side of the glacier, the identity of that moraine is sufficiently marked by its colour, and by the regular rise, above the general surface of the glacier, of its top, which remains tolerably even for some way down, being beyond the limit of the disturbance caused by the crevasses along the edge of the glacier; about half way down to the lower end of the glacier, however, the full action of these crevasses reaches the whole of the moraine, and it is scattered or lost sight of in the general confusion of surface.

An epoch of peculiar destructiveness to the mountains passed by the glacier is marked on one part of this moraine by an accumulation of huge masses of rock, from 20 to 30 feet square, and as much as 15 feet high, and the stones found on it are generally larger than those on any of the other moraines; the true west lateral moraine, below the tributary glacier, is not very large, nor is its top much elevated above the bottom of the valley, excepting quite at its end. This is probably owing to the level of the valley on this side being higher, rather than to the top of the glacier boing lower. The bottom of the valley slopes from the cliffs at its sides inward. On the east, the edge of the glacier is at some distance from the cliff, and the bottom of the valley has dipped considerably where it meets the foot of the moraine, the summit of which, on that side, is high above the valley. On the west side, the glacier edge is close to the cliff: the bottom of the valley will therefore be higher. I did not notice any difference of level in the two sides of the valley.

The lateral moraine of the south-east side of the glacier is very large. Its top rises, on an average, probably 250 feet above the bottom of the valley. Along its foot runs a stream, gradually increasing in size, that collects the drainage of the open part of the valley, and of the outer slopes of the moraine. The lower part of this slope is a mass of loose stones and earthy gravel, which rolls down from above, as the face of ice, which is visible in the upper 50 or 60 feet of the slope, melts and recedes. This process is seen constantly going on. On the inner side, the top of the moraine is 40 or 30 feet above the level of the clear ice of the glacier.

Besides these lateral moraines is a medial one, which, similar to several described by Professor Forbes, is first seen as a dirty stripe among the white ice-cliffs of the fall at the head of the north glacier. As it comes down the level ice, it gradually begins to assume the decided appearance of a moraine, and, increasing by degrees, at last becomes very large. It continues in a well-defined form for some short distance beyond where the western moraine is dispersed; but there it is also scattered over the ice, and the two become blended together, and ultimately extend to meet the debris which is similarly dispersed by the eastern moraine from the opposite side of the glacier.

The whole of the moraines in the middle of the length of the glacier, where it is most regular, are very considerably raised above the general surface of the ice, which in some parts is, I should think, as much as 100 feet below the tops of the western and medial moraines. It is not to be supposed that this great elevation is caused to any considerable extent by the mere mass of rocks and rubbish collected in the moraine; it results from the ice below the mass being protected by it from external melting influences, which constantly depress the level of the clear ice beyond the moraine. On the very tops of the moraines pure ice was often seen hardly covered by the stones.

The protection given to the ice by the great lateral moraines, raises the sides of the glacier so much, that a very considerable hollow is caused in its middle, which is a striking feature in the first appearance of its lower extremity.

The ice of which the glacier is composed, agrees most exactly in its nature with the Alpine glacier ice, as described by Professor Forbes. It is perfectly pure and clear, but where seen in considerable masses, stripes of a darker and lighter bluish-green are distinctly visible. It is composed of bands of ice, containing small air-bubbles, alternating with others quite free from them. In many places the surface presents a striated appearance, arising from the different degrees of compactness of these differently coloured bands, and their consequently different rates of melting.

The direction of these coloured veins, as seen in crevasses, or in the striated surfaces of the ice, follow laws exactly similar to those observed in the Alps. The dip was most distinctly inwards, *i. e.*, towards the longitudinal axis, and upwards, *i. e.*, towards the origin of the glacier in every part; the stratification being more perpendicular near the head, and more nearly horizontal in the lower parts. The direction of the strata was also very clearly marked in many parts of the ice, and was plainly in curves, having their branches nearly parallel to the sides of the glacier, and their apices directed downwards ; the curvature in the centre not being at all sudden. I nowhere could perceive "dirt-bands."

The crevasses (perhaps owing to my visit having been made somewhat early in the summer) were much less numerous and terrific than I had expected. Although considerable detours were at times necessary in crossing them, I remember no place that I thought dangerous or difficult to pass. They are developed across the direction of the glacier's length, along both of its sides, commencing from the small tributary on the west side, and from the union of the eastern glacier on the other, and continuing almost to the end, those on the west side being, I think, the largest. They are generally wider towards the edges of the glacier, closing up as they approach the centre. They are nearly vertical, and are directed from the sides upwards or towards the head of the glacier, those on the west bearing nearly east and west, those on the east bearing nearly north and south, thus forming angles of about 45° with the axis of the glacier.

Many pools of water (the Baignoirs of the Alps) were seen on the surface of the ice ; some of the largest were said by our guides, who are in the habit of visiting the glacier, to be found in the same place every year. The clear surface of the ice everywhere assumes a more or less undulating form, from the action of the water that drains from it as it melts; and the small streams into which the drainage collects, end, as in the glacier of the Alps, by falling into some of the crevasses. The remains of the last winter's snow was hardly perceptible on any part of the glacier.

The occurrence of stones standing up on bases of ice (glacier tables) above the general surface of the glacier, is common; but all that I saw were small. I also observed what appeared to be imperfect glacier cones, or the remains of them, but these also were small.

I examined the effect the glacier produced upon the rocks: I found it covered with grooves or scratches, sloping in about the same direction as the surface of the ice at the spot. These grooves extend to 20 or 30 feet above the present level of the glacier. I also observed, that almost everywhere a space was left between the rock and the ice, the latter appearing to shrink from contact with the former. This was, of course, the effect of the heat of the rock melting the ice. I regret that an attempt that I made to measure the actual motion of this glacier proved ineffectual, owing to circumstances which it is not necessary to detail.

The valley of the Kuphinee, for a mile or two below the end of the glacier, has much the same general character as that of the Pindur, but is more rugged and desolate in appearance. A fine peak of pure snow (probably Nunda Kot) is seen from below the glacier, but is lost sight of behind an intermediate point, on a nearer approach.

The direction of the glacier is almost due north and south, and the whole breadth of the valley, in its upper part, about ¾ of a mile, is occupied by it. It commences about two miles above the river's source, in a very precipitous fall of ice. We went up about 200 feet, by the lower part of this, much beyond which it would probably have been impossible to ascend, owing to the excessive steepness above. A cliff of ice about 60 or 70 feet high, rose immediately above the point which we reached. The ice was perfect, with the ribbon structure quite visible; the bands were very highly inclined, and I think further apart than in the lower parts of the glacier. The direction of the structural lines was in no degree parallel to the sides of the glacier, but much more nearly perpendicular to them. The precise contrary of this was observed by Professor Forbes, under apparently similar circumstances, in the Glacier du Talefre, in the Alps.

From the foot of the fall, the surface of the glacier was on the whole very even, though its slope downwards was very considerable. It still had remaining, on its upper half, a good deal of unmelted snow, which was disagreeable to walk over, as it was seldom strong enough to make us indifferent to what was under it.

The main glacier is joined by two small tributaries on the east, and by one on the west; all are highly inclined, and bring down considerable quantities of debris. The moraines are altogether confined to the sides of the glacier, though many small stones are scattered over every part of the ice. Here, as in the glacier of the Pindur, the protection given by the moraines to the ice on the sides, raises them greatly, and leaves a deep hollow in the middle of the glacier at its end. The crevasses here also are most strongly marked near the sides, and are inclined at an angle of about 45° from the longitudinal axis, downwards. The structure of the ice is in all respects precisely as was seen in the Pindur glacier. I am unable to offer any decided opinion as to whether these glaciers have ever varied considerably from their present limits. During the very short period of my visit to these regions, I saw no direct evidence of it. The shepherds who take their flocks to the pastures in the valleys near the glaciers during the summer months, (for there are no fixed habitations within 14 or 15 miles of them), have no idea of any motion in the glacier, but say, that they suppose the ends of them to be gradually receding. Their statements are, however, of a very vague nature, and, as far as I could judge, are founded on their views of what ought to be, rather than what really is. Some very decided change in the state of things is however certainly indicated by the long plateaux, which I before mentioned, running for a mile or two below the present terminations of both glaciers, nearly parallel to the rivers, but several hundred feet above them. I consider it to be impossible, that these level banks above the rivers, have been caused by deposits from the ravines in the sides of the valleys, for such deposits would have had very irregular surfaces; and indeed their present effect in destroying the regularity of the plateaux is everywhere visible. Had the same appearance been noticed in any other part of the river's course, it would at once have been attributed to the action of the water at some former period; and it would have been supposed that the bed had afterwards been excavated to its present depth. If this was the case, the glaciers, while the plateau was forming, must either have terminated considerably higher up the valleys, or have stood altogether at a much higher level; in either of these ways, the water could have been delivered at a level sufficiently high to form the plateau. But it may admit of doubt, whether the quantity of water in the rivers, as they are at present, is sufficient to account for such an extent of level deposit, or for such a depth of erosion of their beds; for at this great elevation, they are not subject to those violent floods that occur lower down; for nearly half the year, too, they must be almost inert.

The only other way that occurs to me of accounting for the appearance, is, that it has been occasioned by an *extension* of the glacier, and that the level top of the plateau shews the limit to which the tops of the moraines reached, as the glacier gradually receded. From the very cursory nature of my examination of the matter, however, I am unable to do more than point out the fact, and what possibly may have caused it.

There is another circumstance relating to these rivers, which is also worthy of notice, namely, that in the upper two or three miles of their course, their fall is considerably less, than in two or three miles immediately succeeding those. Thus, in the Kuphinee, the average fall in the first three miles is about 400 feet, in the next four miles, about 650 feet per mile; but, as the average is only about 160 for the next eight miles, it is highly probable that the fall in the fourth and fifth miles will be considerably greater than in the sixth and seventh. I therefore infer, that it is quite possible that the fall in the fourth and fifth miles may be as much as 800 feet per mile, or even more, which the appearance of the rivers would fully justify.

Smaller extensions of the glacier of the Pindur were visible in many places. They were marked by mounds of a rounded form covered with grass, projecting from the modern moraines in a curved direction concave to the glacier. I did not remark them at the Kuphinee. I would here observe, that in this climate, where we are subject to periodical rains, persons should be cautious in concluding that piles of rocks in long lines are moraines, even though their edges are in no way water worn. On both of these rivers I saw many instances of such heaps of rocks which might very easily have been thought moraines; and though from their immense extent, and the great size of the blocks they contain, it is not easy to believe that they have been formed by the action of water, more particularly as the rocks have perfectly sharp edges, and as there is often no appearance of water ever having been near them; yet they have certainly been brought down by torrents, and may be easily traced up to ravines in the mountains.

The term snow-bed having been hitherto applied by travellers in these mountains, (with one exception,*) both to true glaciers, and to mere beds of unaltered snow, I will shortly explain what is meant by it when used in the latter, which is the correct, sense. In many parts of the higher valleys real beds of snow lie far below the limit of perpetual snow for the greater part of the year, and some would probably be permanent at very low elevations were they not destroyed by the rain during the rainy season. These snow-beds are formed by avalanches, as is sufficiently proved by their form and position. On the Kuphinee river we have a fine example of a snow-bed, which occurs at an elevation of 10,800 feet.

It came down from a ravine, and entirely covered the river, which flowed under its whole length. The snow extended but little beyond the upper side of the ravine, but was prolonged far down the river on the lower side. Its surface

* I allude to Major Madden, who has given a short account of the glacier of the Pindur in a late Number (176) of the Journal of the Asiatic Society of Bengal.

was marked by curved hills. This is evidently precisely the form that would be assumed by snow falling down the ravine into the river. The slope of the river bed being great, the avalanche would naturally continue its course down it, after having filled the channel immediately in front of the ravine. The fall of an avalanche in the upper part of this valley, gave me an opportunity of seeing the motion of loose snow in large masses ; it was very similar to that of a fluid body, the snow appeared rather to flow than to fall. So here, the snow descending through the ravine, gradually filled the river channel, the main supply moving with the greatest velocity down the middle, but sending off, all along it as it went on, particles to the sides. Its head would therefore advance in a convex curve, as the central particles moving directly forward would always keep in advance of those that spread out to the sides. The end of the snow-bed takes the curved form, and a succession of smaller avalanches would mark its surface with numerous curves of the same sort.

In the last two miles of the approach to the Kuphinee glacier we crossed two snow-beds, both of which were upwards of a quarter of a mile wide, and extended from the ravines in which they originated, right across the valley from side to side, entirely covering up the river.

The surface of many of the snow-beds has a sort of rippled appearance, caused by the protection given by grass and leaves blown upon the snow to the parts immediately under them. The snow itself is generally firm, and receives but a slight impression from the foot of a man walking over it.

I have estimated the heights of these glaciers from observation of the boiling-point of water as follows ; the results will certainly be within 500 feet of the truth.

	Feet above the Sea.
Lowest point of the glacier of the Pindur and source of the river, ...	11,300
Surface of the glacier at the commencement of smooth ice,	12,000
Lowest point of the glacier of the Kuphinee and source of the river, ...	12,000
Surface of the glacier at the commencement of smooth ice,	13,500
Diwalee, union of the Pindur and Kuphinee, . .	8,200

The limit of perpetual snow here being about 15,000 feet above the sea, in the one case the glacier comes down 3700, and in the other 3000 feet below it. At the Kuphinee glacier, a mass of *Rododendron campanulatum*, a shrub six or eight feet high, was growing within thirty yards of the ice. There were no shrubs of any size at the Pindur glacier, but grass and flowers were at both places flourishing considerably above the level of the ice.

Having now concluded the record of my own observations on the two glaciers seen by myself, I will add two extracts from the journals of travellers in these mountains, which most clearly prove the existence of two other glaciers, both of great size; one at the source of the Bhagiruttee or Ganges, the other at that of the Goree, which is one of the main feeders of the Kalee or Gogra. The first extract is from a journal by Captain Hodgson, of a visit to the source of the Ganges, in the year 1847 (*Asiatic Researches*, No. xiv., 4to, pp. 117–128.) Captain Hodgson thus describes the first appearance of the glacier, from which the river rises.

"The Bhagiruttee or Ganges issues from under a very low arch at the foot of the grand snow-bed."—"Over the debouche the mass of snow is perfectly perpendicular, and from the bed of the stream to the summit, we estimate the thickness at little less than 300 feet of solid frozen snow, probably the accumulation of ages; it is in layers of some feet thick, each seemingly the remains of a fall of a separate year. The height of the arch of snow is only sufficient to let the stream flow under it."

He ascends the glacier: "This vast collection of snow is about 1½ mile in width, filling up the whole space between the feet of the peaks to the right and left; we can see its surface forward to the extent of four or five miles, or more." —"General acclivity, 7°, but we pass small hollows in the snow, caused by its irregular subsiding; a very dangerous place; the snow stuck full of rubbish and rocks imbedded in it. Many rents in the snow appear to have been recently made, their sides shrinking and falling in."—"Ponds of water form in the bottom of these."

"It was remarked above, that the snow of the great bed was stuck, as it were, with rock and rubbish, in such a manner, as that the stones and large pieces of rock are supported in the snow, and sink as it sinks; as they are at such a distance from the peaks as to preclude the idea that they could have rolled down to their present places except their sharp points had been covered, it appears most likely" that they came down like snowballs with avalanches. "It is not easy to account for the deep rents which intersect this snow-bed, without supposing it to be full of hollow places." The source of the Ganges is stated by Captain Hodgson to be 12,914 feet above the sea.

The next is an extract from a journal of Lieutenant Weller, printed as a note to a journal of Captain Manson, (*Journal of the Asiatic Society*, No. 132.)

"I went to see the source of the Goree River, about a mile north-west from Milum. The river comes out in a small but impetuous stream, at the foot of apparently a mass of dirt and gravel some 300 feet high, shaped like a half-moon. This is in reality a mass of dark coloured ice (bottle-green colour), extending westward to a great distance, and covered with stones and fragments of rock, which, in fact, form a succession of small hills. I went along this scene of desolation for a long space, but could not nearly reach the end. Here and there were circular and irregularly shaped craters (as it were), from 50 to 500 feet in diameter at top, and some of them 150 feet deep; the ice was frequently visible on the sides, and at the bottom was a dirty sea-green coloured pool of water, apparently very deep. The bases of the hills on either side, and frequently far up their faces, are one succession of landslips; but, from their distance, I do not believe it possible that the debris in the centre of the snow-bed valley can have fallen there from the side hills." Lieutenant Weller also says of the same glacier in his journal, published in the *Journal of the Asiatic Society*, No. 134:—"The mass of desolation, as described at the source of the Goree, continues thus far up, that is, about four miles, and how much farther no one will or can tell me. The fissures hereabouts are narrow, instead of being crater-like, and the ice, when visible, is more nearly the colour of snow. On the opposite (south) side, huge accumulations of ice and gravel are to be seen in the openings between the hills. Once on either side I had a view of the old ice high upon the hills; its light sea-green colour, with strongly defined and fantastical lines of shape (castles, stairs, &c.), formed a very pleasing and grand appearance." This glacier is known to be six or seven miles long; its lower extremity is at 11,600 feet above the sea.

In the published journals of travellers in the Himalaya that I have seen, I have not met with any other accounts of glaciers sufficiently distinct to be worth quoting, though we not unfrequently come across a snow-bed that seems suspicious. I am, however, fully satisfied of the *actual existence* of many other glaciers, both from the verbal accounts of Mr Batten, who has been a resident in Kumaon for many years; of my brother, Mr H. Strachey, who visited several of the passes into Thibet last year; and of the Bhotians (the natives of the valleys immediately below the snowy ranges); and from having myself had distant views of several.

From these sources I am able to affirm positively the existence of glaciers at the heads of the following rivers, viz.: —the Vishnoogunga (near Budrinath); the Kylgunger, the Koourgurh the Soondurdoonga, all rising from the northern side of Tresool and Nunda Devee; the Ramgunga (that which falls into the Surgoo, not the great river of the same name); the Piltee, an affluent of the Goree; and the Gonka, which rises near the Oonta-doora or Joohar, pass into Thibet.

I therefore conclude, that in the Himalaya, as in the Alps, almost every valley that descends from the ranges covered with perpetual snow, has at its head a true glacier; and in spite of Mr Elie de Beaumont's ingenious fact, that the seasons here "have no considerable variations of temperature," and that "the thaw and frost do not separately penetrate far enough to convert the snow into ice," I am of opinion, that the very great intensity of all atmospheric influences, including variations of temperature, should render these mountains one of the most favourable fields for the investigation of glacial phenomena.—*Journal of the Asiatic Society of Bengal*, New Series, No. viii., p. 794.

Note on the Temperature of the Spider; and on the Urinary Excretion of the Scorpion and Centipede. By JOHN DAVY, M.D., F.R.S., Lond. and Edin., Inspector-General of Army Hospitals.

In a former communication made to this Journal, I have spoken of spiders as belonging to the class of cold-blooded animals. Though this I believe is generally admitted as a fact, I am not aware of any precise observations that have been made and published confirming it. I am induced in consequence to give the following, which, although the number is very limited, may in part at least supply the supposed deficiency.

The subject of the first trials I shall mention was a large species of Mygale, not uncommon in Barbadoes, the body of which was about an inch long. A small thermometer, with a projecting bulb, applied to its abdomen, was stationary at 86·25° Fahrenheit, when a similar one placed under the glass vessel in which the spider was confined stood at 86°. The following day, the difference between the two thermometers was a little greater; that in contact with the spider was 88·5°; that under the glass 88°. On this occasion the spider was placed on cotton-wool, and the bulb of the instrument was between this bad conductor of heat and the abdomen of the animal. I may add, that the previous nights it devoured the soft parts of a beetle, and voided a considerable quantity of urinary excrement, consisting almost entirely of xanthic oxide. The trial of the thermometer on this spider was repeated several times, and with the same result.

In Trinidad, as well as in some of the other West Indian islands, a very large spider (*A. avicularia*, Linn.?) is met with. At my request, Mr Longmore, assistant-surgeon of the 19th regiment, stationed in Trinidad, was so good as to institute some trials on it, to determine its temperature. In the first he made, he informed me that a delicate thermometer, the bulb of which was grasped by the spider so as to be surrounded, rose in one instance from 85° to 86½°; in another from 83° to 85°. In some other trials, made on the same spider, taking precautions which I suggested to him, he found the thermometer under the abdomen, and in contact with it, from one-half to three quarters of a degree higher than in the air of the box in which the spider was confined; and he stated that the same results followed the experiment when made at different atmospheric temperatures. These last results, of course, I consider, as did also Mr Longmore, the most accurate.

In connexion with its temperature, I have thought it worth while to ascertain the proportion of carbonic acid formed by the spider in a certain time. The spider, the temperature of which I had tried, was confined in a glass jar, over water of the capacity of 23 cubic inches, and holding this quantity of common air. After 24½ hours, (the temperature of the room the same at the beginning and end of the experiment), calculating the absorption that had taken place, the diminution of the volume of air, and the after diminution by agitation with lime-water, it was found that there was a total diminution of 2·11 cubic inches of air, so that about this quantity of carbonic acid, it may be inferred, had been formed. In a second experiment, on another species of Mygale, about half the size of the former, after three days confinement in 13·6 cubic inches of atmospheric air, nearly a cubic inch (·97 of a cubic inch) appeared to be formed. The spider, at the end of three days, was alive and active. These results, on the quantity of oxygen consumed by these spiders, in the formation of carbonic acid, or the animal-heating process, may be considered in accordance with the degree of temperature they have been observed to possess.

I have mentioned, that the spider first used in the trial on temperature, devoured the soft parts of a beetle: of this I satisfied myself by careful examination of the remains. And, I may add, that from repeated observations, I am sure, that spiders do not, according to popular belief, feed on the juices of the animals they make their prey, but on their muscle and other soft parts. The same remark, the result also of observation, applies to the scorpion.

As regards this last mentioned animal, there is another popular belief, which I have no doubt is equally ill-founded, viz., that if an attempt be made to confine it, it will destroy itself by thrusting its sting into its head. I apprehend that most scorpions that die shortly after they have been placed in confinement, have been hurt in being taken, and die in consequence. The committing of self-destruction on loss of liberty, excepting it be done instinctively, implies not only a reasoning power and process, but a knowledge of the effects —that is, of death,—a knowledge which we can hardly suppose any animal but man to possess. But, apart from this general consideration, I may mention, that the only scorpion I have had, that I have taken uninjured, has lived, and is now living in confinement, and feeds well, eating the soft parts of flies, and of small cockroaches, which it kills, and seems to be in the enjoyment of perfect health, and nowise repining under the loss of liberty.

This scorpion, a small brown one, with transverse stripes on its back of a lighter hue (*S. americanus*), has enabled me to make trial of its urinary excrement. Like that of spiders, it is voided in a semifluid state, shortly becomes solid from the evaporation of the aqueous part; is of a greyish hue; under the microscope is seen to consist chiefly of spherical granules, of from about $\frac{1}{8000}$ to $\frac{1}{12000}$ of an inch in diameter; and examined chemically, is found to have the properties of the xanthic oxide. I have never been able to detect in it any traces of lithic acid, and have sought for it in several specimens. It is remarkable that almost the whole of the excrement of this animal appears to be urinary. It is voided often, and, in proportion to the size of the scorpion, in large quantity. A like remark is applicable to the spider, but not to the centipede. Hitherto my observations on this secretion of the scorpion have been limited to one example; and, in the instance of that of the centipede, they have been equally limited.

The centipede (*Scolopendra morsitans*), from which some excrement was obtained for examination, was about six inches long: it died, after having been about a fortnight in confinement without eating; it had been hurt in being taken. During this time it twice voided excrement—a dark small cylindrical mass, partially covered with a whitish incrustation. This whitish matter, separated and examined apart, was found to consist chiefly of lithate of ammonia: under the microscope, it was seen to be composed of granules of about $\frac{1}{8000}$ inch in diameter, and acted on by nitric acid and heat, it yielded the purple compound characteristic of lithic acid. The dark, almost black matter, composing the principal part of the excrement, under the microscope appeared as a very mixed debris, amongst which sand, in very fine grains, was observable, but nothing else, well defined. No doubt, it was fæcal matter, and it would seem to indicate that the centipede is a coarse feeder.

BARBADOES, *October* 31, 1847.

Description of a new Pyrometer. By Mr ALEX. MILLER, Liverpool. With a Plate. Communicated by the Author.

Thermometers being found inapplicable to the measurement of the higher ranges of heat, Musschenbroek, about the year 1730, was led to make use of the expansion of metal rods instead of that of mercury. Since that period pyrometers and metallic thermometers, with few exceptions, have been made on the same principle, though varying in form; the expansion of the rods being assumed as proportional to the temperature.

The exceptions to Musschenbroek's method may be briefly noticed. Wedgwood's pyrometer is founded on the property that clay possesses of contracting by heat. Achard's resembled the common thermometer, semi-transparent porcelain being substituted for glass, and a fusible alloy for mercury. Mr Prinsep, assay-master of the mint at Benares, proposed the employment of alloys of various metals, in different proportions, which melted at various degrees. The expansion of air by heat has also been employed in the measurement of high temperatures.

The principle of the pyrometer that forms the subject of this communication, in the opinions of those* in whose judg-

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* Professors Faraday and Melson.

ment I have more confidence than in my own, is new in its application, and correct in theory; but the practical utility of this contrivance remains to be tested. The difficulty that attends the invention of an instrument of this kind, that in its use is submitted to the torture of fire, may be inferred from the disagreements found in tables of temperatures above the boiling of mercury.

My aim has been to make the mercurial thermometer subservient to the measurement of high heats. As in mechanics, a comparatively small weight, placed on the lever of a steelyard, counterpoises and determines the weight of the load, it seemed also possible by some method to determine, by the thermometer itself, temperatures beyond its range.

With this view experiments were first tried with a short cylinder of iron, of one inch diameter, a tube of sheet-iron, and a thermometer, proceeding as follows:—The iron cylinder, after being heated, was dropped into the tube; the thermometer, graduated on the stem, was suspended at a small distance above it, and at the same distance in all experiments, to receive the impression of radiated heat; the rise of the thermometer during a given time was observed. It was supposed that the thermometer would be affected according to the intensity;—that if the iron heated to 100° above the atmospheric temperature caused the thermometer to rise 12° in four minutes, 200° would cause it to rise 24° in the same time.

The following improvement was made on this arrangement. The thermometer was bent to a right angle about an inch from the bulb, which was afterwards imbedded to the depth of about half an inch in sand, contained in a metal cup*; the thermometer stem was passed through a hole in the side of the cup, and fixed in an upright position: a cylinder of iron weighing about six ounces, with a thin handle, was heated in mercury to various known degrees, and then applied to the shielded bulb. In each experiment, the degree to which the thermometer rose during four minutes, was noted, and the numbers passed over were counted. The results with moderate heats were tolerably uniform; an increase of 100° in the cylinder producing an increase of about 12° in the ascent of the thermometric column. From results with known heats, a scale was obtained, by which unknown and higher heats were inferred. But as the capacity of iron for heat increases rapidly, all determinations with this metal must be too great in the higher ranges.

In practice, this method was attended with some inconveniences. The sand that surrounded the bulb of the thermometer imbibed moisture from the air in the driest weather: when the cylinder was applied at a red heat, the moisture was converted into steam, and the thermometer quickly rose from perhaps 70 or 80 degrees to the boiling point of water. There was also difficulty in marking the time by a seconds watch, and the ascent of the thermometer at the same instant. A new plan was suggested, in which *time* does not enter as an element in the investigations, and the operation is thus in some measure simplified.

The pyrometer, in its present form (Plate III.), consists of a platinum* cylinder, weight about four ounces; about thirty ounces of mercury, contained in a vessel of sheet-iron, placed in one of wood, with charcoal between; a thermometer, graduated on the stem to 600°. The iron vessel has a cover of the same material; an iron tube, closed at the lower end, and of rather greater diameter than the platinum heater, is secured to the cover by a lip or flange, and passes through the mercury to about one-eighth of an inch from the bottom of the vessel.

The procedure is similar to the above; differing in this, that instead of estimating the heat by its partial effect during a short and given period, it is estimated by its total effect on a mass of mercury.

The platinum after receiving the temperature of the furnace, melted metal, &c., is dropped into the tube, sand is poured quickly over it, and the tube closed with a non-conducting stopper. A lid of wood is pressed down on the outer

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* Platinum has two desirable properties not possessed by wrought iron; it sustains intense heat, without being oxidized, and its capacity for heat is not a rapidly increasing one, nor irregular.

case, through this lid, and the one of iron under, are holes to admit the thermometer to the mercury, the scale is exposed from 30° upwards.

The weight of the platinum is about one-ninth of that of the mercury and sheet-iron surrounding it. Mercury, which forms the chief part of the weight, has nearly the same specific heat as platinum ; the temperature, therefore, when diffused over, or *diluted* in, the mass is lowered to one-tenth, not one-ninth, as the platinum retains its share; thus, a temperature of 2000° (on the supposition that the atmosphere is at zero) would become 200°, and be measurable by thermometers. The diffusion of all heats is completed in the same time, viz., in six minutes when the thermometer becomes stationary.

The scale, it will have been observed, is determined by the relative weights of the mercury and platinum, and may be altered by increasing or diminishing either ; it may be found by calculation, but more accurately and easily by experiment. A scale of 1° to 10° of Fahrenheit has been chosen, partly for the sake of ready notation ; by the addition of a cipher to the number of degrees through which the thermometer has risen, and the addition afterwards of the atmospheric temperature, the original heat is obtained.*

As far as the thermometer served to check and carry out the experiments, the results were found uniform and consistent, or nearly so ; 100 clear degrees imparting 10° to the mass, 200°, 20°, and so on.

The boiling point of linseed oil, estimated at 600° was indicated at 594°. The heat of an ordinary fire varied from about 1200° to 1600°, according to intensity, which is dependent on draught. The heat of a parlour fire is set down by the late Professor Daniell at 1141°. The difference here exhibited was unexpected, nor does it seem to be clearly accounted for by attributing an excess in my determination to

* *Example.*—With the atmosphere at 50°, let it be supposed the thermometer has risen to 145°, the number of degrees passed over is 95; a cipher annexed makes 950, and the weather temperature of 50° added, gives 1000° as the original heat.

the increasing specific heat of platinum, for this might be supposed nearly balanced by the increasing rate of expansion of platinum in the other determination of 1141° with the register pyrometer. The increasing capacity, and the expansion of metals in general, seem to bear a relation to each other, and in platinum both are small. If the temperature assigned to an ordinary fire by this pyrometer be *really too great*, the error, I apprehend, can be ascribed only to progressive specific heat; yet, no such increase was shewn in the previous experiment with boiling oil, that gave a result rather under 600°, the temperature indicated by an open thermometer.

The fusing point of copper, and the white or welding heat of iron, were also shewn at higher ranges, but much under those assigned by Morveau in his corrections of Wedgewood's scale.

It is worthy of remark, that the determinations by Daniell's first pyrometer (described in Brande's Quarterly Journal) were higher when pulleys were used to magnify expansion, than those afterwards given by the register pyrometer, in which a lever is used instead of pulleys. The melting point of cast-iron by the former was 3479°, by the latter 2786°. Dr Brewster, in his edition of Ferguson's Lectures, has pointed out a singular oversight in the construction of Ferguson's pyrometer, with respect to the lever employed to increase expansion to the eye. He says, in a note (vol. i. p. 20), "It is wonderful how the author and other writers on natural philosophy should have overlooked the striking defect in the principle upon which this new pyrometer is constructed." The error is then pointed out, with references to the drawing of the instrument in the book of plates. Dr Brewster adds, "As the arms of the two levers, therefore, are continually changing their proportion, every pyrometer constructed upon the principle of the lever must give a very inaccurate result."*

* The error in Ferguson's pyrometer might be rectified by a scale of equal parts, laid down, not on the arc, but on a tangent to it, parallel to the expanding bar.

The levers in Ferguson's pyrometer act like levers of the third kind; in Daniell's, like one of the first kind: but it is difficult to decide, by mere inspection of the diagram that accompanies the description of the register pyrometer, whether an error similar to that in Ferguson's arrangement, or indeed, whether any error exists in Daniell's scale. I have not had an opportunity to inspect the instrument itself.

All who have brought forward pyrometers endeavour to connect them as supplements to the thermometer, which, it is now generally admitted, is not really consistent with itself from its lower to its higher limits; an approximation to an accurate continuation of Fahrenheit's scale is therefore all that can be expected. The difficulties that stand in the way of a solution of the problem, seem to arise from the small expansion of the metals employed, which thus requires the intervention of levers and pinions, that may not "perform with theoretical accuracy;" from unequal expansions by equal increments of heat; and in the method now submitted, from the increasing specific heat of metals. At present, to me it seems possible to determine, within 100° at least, a temperature not greater than 1200°, or double that of boiling oil, by means of the fusible alloy, and by a method (perhaps unsuitable for a permanent instrument) in which those suspected causes of error may be evaded. If opportunity be afforded, and if the inquiry be attended with even moderate success, I may, with permission, take leave to return to this subject.

Meeting of Association of American Geologists and Naturalists, held at Boston, September 27, 1847.

This Association met, according to adjournment, in the Marlborough Chapel, Tuesday morning, at 10 o'clock.

The meeting was called to order by Dr John C. Warren, of this city, chairman, *pro tempore*. The proceedings of Monday were then read by the secretary, Dr J. Wyman. Professor Silliman, of the Standing Committee, after making a few remarks relative to the death of Dr Binney, nominated Professor William B. Rogers as permanent chairman of the present meeting, and he was unanimously elected. Previous to the commencement of the regular proceedings, Mr Teschmacher of this city, informed the members that large masses of the Lake Superior copper-ore were left at the Providence Railroad Depot, and that individuals interested might have an opportunity of examining them.

A paper was presented by Mr B. L. C. Wales upon the formation of the Mississippi Bluff, near Natchez. This paper, in the absence of Mr Wales, was read by the secretary. It went to explain the respective agencies of diluvium and glaciers in the formation of the Bluff. It also explained the manner in which animal remains had been found in the ravines, near the locality, shewing that land slides and floods were continually depositing in the ravines bones and other articles from the higher regions, and which from time to time had been dug up and exhibited. There was a large number of specimens from the locality, consisting of fossil woods, favosites, carnelians, jaspers, and ochres, &c.

Mr P. A. Browne, of Philadelphia, read a paper, entitled "Animal Torpidity." He first treated of the respiration of hibernating animals. With mammals the respiration does not cease at once, but gradually, and no oxygen is consumed by the animal in a completely torpid state. The respiration of the torpid state may be only imperfect, as, for instance, when the animal breathes and then ceases from breathing for minutes, and it may be for hours. Animals, when about to enter the torpid state, seek retirement. The mammals roll themselves up into as small a compass as possible, and retire into holes or caverns; the mollusca retreat into their shells; flies, spiders, &c., creep into holes.

A Hamster kept in a box of straw, in a sufficiently cold place, did not become torpid; but when buried in the ground he became torpid, and revived as soon as he was dug up. Hamsters have been kept in a cage and fed, eating during the season when they usually hibernate. Opinions are various upon the point of the total extinguishment of respiration during torpidity. Some naturalists assert, that in hibernation animals do not breathe, while others contend that respiration is not extinct. A torpid animal immersed in carbonic acid gas will not die. The respiration of animals is subordinate to temperature —in summer quick; in autumn slow; in winter, none at all. Experiments have shewn that hibernating animals consume oxygen, considerable in volume, when in an active state; that the consumption diminishes as the temperature falls; that they can exist in an air which will neither support life nor combustion; that in a torpid state the consumption of oxygen is small; and that in a perfect state of torpidity no oxygen is consumed, and there is no respiration.

The Alligator, when about to hibernate, takes a pine or cypress knot in its mouth, completely closing it; it then retires into holes under water, where it remains until the warm weather in the spring comes on. A water-rat was ploughed up in England, in the year 1769, completely enclosed in a hibernaculum. A mouse was dug up in 1798, enclosed in a ball of clay about the size of a goose egg; when brought into a warm room, it revived and escaped. Twenty or thirty frogs were once taken in a torpid state from a depth of twenty feet in the earth, where they must have remained a hundred years or more. The snail, when about to hibernate, retires into its shell, closing its operculum with a partition of a silky membrane, and a deposite of carbonate of lime. Sometimes as many as six membranous partitions are formed between the operculum and the recess of the shell. In this state it remains for months, and the only evidence of life is a susceptibility to muscular sensation. It lives without food, without air, and exercising none of the animal generative functions. It does not subsist upon the modicum of air remaining in the shell, as this has been examined and found capable of supporting combustion—this fact shewing that it had not been breathed.

Torpidity is neither life nor death, but an intermediate state—neither is it sleep in the ordinary sense of the word.

The circulation of hibernating animals is suspended in a state of profound torpidity.

The digestion also is arrested, and all food is declined. A hedgehog kept in a room without fire, ate of its food regularly up to December, when it refused it, went into a torpid state and remained so during the winter, never eating food laid before it. A land tortoise kept for forty years, ate voraciously in summer, but refused all food in winter when hibernating. Absorption goes on, but this is an entirely different process from digestion. The secretions are also arrested. The organs of relation are paralyzed. A torpid dormouse cannot be roused by a shock of electricity; bats do not feel wounds or hurts, and can be aroused only by heat and currents of air.

Are the organs of reproduction suspended? Upon this point a difference of opinion prevails. As we understood Mr Browne, he was of the opinion that during a torpid state they have nothing to operate upon but their fat.

In the anatomical structure and physiology of hibernating animals, a similarity is observed, especially in the construction of the thymus gland. Some naturalists are of the opinion, that fat or the omentum is provided as a covering from the cold or for consumption, while others look upon it as purely an accidental circumstance. But Mr Browne is of the opinion that fat is not an accidental circumstance, but has to do with hibernation. The blood remains in a fluid state during hibernation.

Mr Browne was of opinion that the fibrine and albumen which was deficient in the blood of hibernating animals was converted into *fat;* in consequence of which the blood was preserved from concretibility and the storehouse of fat was laid up, upon which the animal subsisted when digestion was extinguished.

There is nothing in the habits of hibernating animals to distinguish them, for their habits vary in different countries. Hibernation may depend on a difference of temperature. Lizards hibernate in France and do not in the Island of Santa Cruz.

The immediate causes of torpidity are cold, heat, drought, want of oxygen, and necessity for repose.

Dr J. C. Warren expressed his gratification at the remarks made by Mr Browne. He said that the use of the omentum, about which there had long been a difference of opinion, was to afford a soft cushion for the sensitive intestines, which are always put in pain by pressure. It may also serve as a reservoir for food when the animal is not in a state to digest it. In fevers and consumption the fat is taken up by the absorbent vessels to supply the want of food. The Doctor's impression was, that hibernation was the result of cold acting on the nervous system, and through this system paralyzing all other parts of the body.

Professor Agassiz did not agree with Mr Browne upon the point of the cessation of circulation during hibernation. He asked what experiments had been made to test this point? Mr Browne replied, that a French naturalist, M. Sacy, who had investigated the subject, had made a thousand experiments. Mr Browne had added upwards of forty upon reptiles. Professor Agassiz was of the opinion, that until the membrane of the wings of bats in a torpid state had been examined by a microscope, to see whether the blood circulates, it was not proper to pronounce decisively that circulation ceases. He was further of the opinion that until it had been shewn that the species of lizards in France and Santa Cruz were identical, it would not do to assert that hibernation depends on the difference of climate.

Remarks were also made by Mr S. S. Haldeman of Carlisle, Pa., and Dr Samuel Jackson of Philadelphia. The latter gentleman expressed the opinion that respiration was not entirely suspended. Professor Agassiz stated that a friend was investigating most minutely the subject of the hibernation of the dormouse, at Neuchatel.

Dr F. Roemer of Berlin, Prussia, made a report on the results of a geological tour recently made in Texas. The fossils of the corresponding formation of the Old and New World were compared, and reference was made to their geographical distribution. He had ascertained that the isothermal lines of the cretaceous epoch (as indicated by the fossils) were the same on the two continents of Europe and America, as at the actual epoch.

Professor S. S. Haldeman presented an interesting fact in the geographical distribution of animals. He stated that an insect was sent to him from Rio, by Dr J. C. Reinhardt, with information that this or an allied species, had been seen by him on board the United States ship Constitntion, in Cochin China, and subsequently in all the ports of the Pacific—the ship touching at the Sandwich Islands and Western Mexico, and passing Cape Horn and Brazil,—a wider geographical distribution than has heretofore been given to this genus. The insect proves to be an Evania, and its extensive distribution is attributable to the fact, that this genus is parasitic on the Blatta (or cockroach) which is known to be extensively abundant upon ships between teh tropics.

In the afternoon, Mr J. E. Teschmacher, of this city, made a communication upon the subject of the fossil vegetation of anthracite coal, shewing that the plants of which the coal is formed are the same as those found in the shale. He treated his subject under the five divisions of the external parts of plants—the internal parts, the vessels, the leaves, and the seed. Several specimens of coal were exhibited by Mr T. to illustrate his ideas upon the subject. They were very beautifully marked by leaves, seed, and vessels of plants.

The Rev. Mr Hincks of London, recently arrived, presented to the Association a specimen of recent vegetation, for their examination.

Professor Agassiz made a communication upon the subject of Echinoderms, shewing that there is no essential difference between the types or families of Echinus and Asterias. He explained many points in the animal economy of the Echinoderms not before known, and shewed the affinities existing between the Echinus and Asterias. He fully proved great uniformity of structure in the two species. He shewed that Asterias has an external skeleton as well as Echinus. He explained the circulation, and while speaking of the functions of certain organs, took occasion to observe that physiologists were greatly in error when they determined an organ by its function. He also shewed the existence of minute aquatic tubes or canals, and of gills in both species. The Echinoderms, when first taken from the water, are of a brilliant red colour, but they shortly change to a bright green after death. They can only be obtained from water to the depth of from 90 to 150 and 200 feet. Professor Agassiz had a month's excursion in one of the United States surveying vessels, Lieutenant Commanding Davis, on the coast, and collected his specimens during this excursion.

Dr Le Conte, of New York, made a communication upon specimens of five new species of fossil mammalia, discovered at Galena, Ill. He believes them to belong to the Tapiroids and Suelline families.

Professor Hitchcock read a letter from Robert Chambers, of Edinburgh, asking for information of the terraces or former sea-levels of this country. Professor Hitchcock said it was an interesting subject, and he hoped that information might be elicited from members of the Association. He stated that terraces existed on the banks of the Jordan in Asia, similar in character to the terraces formed in this country. Upon the banks of our streams there are usually two terrace levels. Mr Chambers says that the terraces of Great Britain bear the same level throughout the country.

Professor Hitchcock thought that this could not be the case in

America; the terraces of the same basin might have corresponding levels, but terraces of different basins could not possibly have the same level above the ocean tide. Professor Silliman hoped that members would turn their attention to this subject. He had lately visited the terraces in New Hampshire, and had an opportunity to examine their internal structure through the cuttings of the railroad through them. They presented a very beautiful appearance. Mr Hall, late geologist of the State of New York, said that the terraces along lake Ontario, had an almost uniform height on both the Canadian and American shores. M. Desor, a French gentleman, stated that the terraces in Finmark were nearly of the same height, but not perfectly horizontal, which was presumed to arise from the subsidences.

On the motion of Professor Tellkampkf, the committee appointed to investigate the subject, whether platina had been found in the gold districts of the south, were authorised to continue their investigations, and report at the next annual meeting.

Wednesday's Proceedings.

Professor Silliman, senior, exhibited a specimen of uncrystallised corundum from North Carolina; and stated, that he had received a specimen of this same mineral many years since from the same state.

Mr Clingman of North Carolina, who had brought this specimen from North Carolina, gave an account of the circumstance of its discovery, which placed the statement that it was a native specimen beyond a doubt.

A paper was read by Mr W. C. Redfield of New York, "on the remains of marine shells of existing species, found interspersed in deep portions of the hills of drift and boulders, in the heights of Brooklyn, on Long Island, near New York city." These remains had long since attracted the attention of Dr Mitchell, and other naturalists of the vicinity, but the true character of the formation, and the peculiar positions in which the shells were found, were not distinctly known to geologists.

It fortunately happened that M. Desor and Count Portalis, while on a visit to Brooklyn a few months since, discovered fragments of these remains in the great masses of boulder-drift in South Brooklyn, through which the new streets are being excavated. At their invitation, Mr Redfield had examined the place in company with Professor Agassiz, and had obtained a variety of specimens, which were found at depths varying from twenty-five to forty feet below the original surface of the hills, in which they were embedded.

Since that occasion, Mr Redfield has found similar remains in those hills about two miles northward from the first locality, and has collected numerous specimens, which he exhibited to the meeting, together with samples or fragments of the original beds inclosing these shells, which had been dispersed by the drift, and thus lodged in the Brooklyn hills. The number of species comprised in the collection amounts to ten or twelve, among which are those now most common to our shores.

These discoveries in regard to the drift appear to agree with those which Sir R. Murchison states to have been made in the drift of Europe. They must be admitted as proving that the most common species of our present molluscs were of prior origin to the hills where the remains were found, and probably older than the entire formation of drift and boulders which is found in the northern states. The species obtained are not such as indicate a colder climate than now prevails. But the shells found by Professor Emmons and others in the pleistocene clays on the borders of Lake Champlain, and by Mr Lyell and others in Canada, appear to belong to a later period of the drift; and Mr Redfield infers that they were brought in from more northern regions, or from deeper waters, by the great arctic currents which must have swept over those regions, during the drift period, when this portion of the Continent was deeply submerged. These polar currents, annually freighted with immense fields and islands of floating ice, such as are now diverted along the shores and banks of Newfoundland, till they are met by the dissolving influence of the Gulf stream, nearly in the latitude of Boston and New York, he considered to have been among the chief agents in producing the remarkable phenomena of the drift period.

M. Desor stated, that discoveries in Scandinavia and northern Europe shewed that the two geological epochs were the same in this country and Europe, that the first deposite of the drift, consisting of coarse clay and gravel, and stratified, was of a turbulent character, while the second was quiet. Boulders have been brought from the northwest, striated and scratched all over their surfaces. How much of the phenomena, presented upon a close survey of these drifts, was attributable to currents of water, M. Desor would leave to others to say. For his own part, he believed that these drifts gave evidence of the action of a body different from water. If the drift and boulders were connected in the action, he fully believed that some other agent than water must be looked for to account for their existence. He could not agree with Mr Redfield in the positions which he had assumed.

Mr Redfield was not disposed to look for foreign causes to account for geological phenomena when one of a more domestic character was entirely adequate to produce these phenomena. Two great polar currents are constantly setting southward—one to the south-east from Hudson's Bay, the other to the south-west from the shores of Greenland—these two currents unite near the Gulf stream, and result in one current. These currents bring along immense masses and islands of ice. These islands bear along rocks, pebbles, &c., collected on them before their separation from the land where they originally formed glaciers; they often ground and remain grounded for months, turned and moved in every possible position by the wind and waves. They would scratch the bottoms of the valleys of the ocean, and would cause the excoriated appearance which the rocks present. In Mr Redfield's view, this agent of currents of water was sufficient to account for many of the geological phenomena which the earth presents.

M. Desor could not conceive how the sides of the valley could be scratched by this agent if the bottoms were. He exhibited specimens of strata or scratched rocks from the glaciers of the Grindelwald and Aar of Switzerland, from Essex county, this State, from Norway, and from the terraces near Lake Ontario. They are all similar in character—one cause must have produced effects so similar. It would not do to say that one cause operated in Norway, another in Switzerland, and still another on this continent. The effects were brought about by the slow action of a mighty body. Glaciers have been observed not only in the Alps but also in the polar regions. In Iceland, glaciers exist for fifty miles in extent. Such being the case, it requires no great effort to believe in the existence of a glacier 300 or 400 miles in extent. It is only necessary that the temperature should be lowered a few degrees for them to exist.

Commander Wilkes, United States Navy, late of the Exploring Expedition, remarked that icebergs have a wide distribution; that they were constantly changing their specific gravity, changing their position—what was a side at one time would become the bottom, &c. In this way the variety of striæ might be accounted for.

Professor Silliman, with no view to object to the glacier theory, for he desired to learn, asked its advocates to explain the existence of glaciers in regions where there were no mountains. The theory as applied to the Alps and other mountainous districts was good.

Professor Adams, of Vermont, made a drawing of a rock of talcose slate in the valley of Union River, Vermont. It was rounded, beautifully polished, and striated on its surface. Near the bottom of the rock was a depression or hollow, and upon the side on which the power, whatever it was, first acted. This hollow was not touched—it presents a rough and jagged outline. The body appears to have struck the rock near its lower edge, and, through the resistance made to its passage by the rock, to have been forced over it, polishing and striating its surface. If water was the agent, it would appear as if it should have acted equally on the depressed or hollow surface.

Professor Hitchcock said the rock referred to by Professor Adams, a representation of which was drawn upon the black board, was a miniature representation of the mountains of New England. Mountains Monadnock and Holyoke were prominent examples. They are all rounded and polished with striæ running in one general direction over their surfaces. It was evident to his mind that whatever body produced these effects, was held in its place by a mighty agency, and that it would have turned to the right or left when it encountered the resistance of the mountains, if it had been possible for it to have done so. Striæ are not only marked upon the rocks *in situ*, but deep valleys are cut in their surfaces. And it is only upon the struck side that these marks are to be observed. He had arrived at the conclusion that, whether in the form of an iceberg or a glacier, it was ice in mass which had produced the effects above referred to. He could not believe that waves of translation were, of themselves, sufficient to accomplish these results.

Professor Silliman asked Captain Wilkes if it was within his own knowledge whether the iceberg in the Southern Ocean, along which the vessels of the Exploring Expedition coasted for some 60 or 70 miles, was attached to the coast or was afloat. He replied that it was not afloat. Mr Redfield could generally coincide in the views expressed by Professor Hitchcock. He felt inclined to admit that icebergs were the principal agency in causing the striæ, rounded, and polished surfaces of the rocks of this country and Europe. He did not believe that there was any such antagonism in the glacier and iceberg theories. It was difficult to explain, on the iceberg theory, how the different striæ have been produced; but he believed it more difficult to explain the same phenomenon on the theory of the glaciers. Waves of translation have been unfrequent.

M. Desor remarked that scratches were observed on the mountains of Scandinavia at a height of 6000 feet, on the White Mountains, New Hampshire, at a height of 5000 feet. Mount Washington, which is some 5300 feet high, is not scratched; its top is covered with loose boulders, presenting a fine specimen of what has been denominated a lake of stones. Just beneath the summit of this mountain the scratches take the general direction of the scratches in the harbour of Boston. The scratches are observed at heights of 5000 feet, 10 feet, and below the surface of the water, but to what depth is not at the present time known. The same is true of the mountains of Scandinavia. The glaciers of Greenland do not run beneath the sea, but form a vertical walk at its surface, where the water melts the ice, and large icebergs are broken off and float away. Murchison says that glaciers have left their marks as far as the mountains extend, but that currents have produced the phenomena observed in the valleys. This cannot be true, for the striæ of the mountains and valleys preserve one general direction. Now the striæ being similar in character when observed in different parts of the world, he was led to conclude that one general course had produced these effects.

Mr Redfield did not think that the striæ were marked upon the mountains and valleys at the same time.

Remarks were also made by Dr Reed, and Prof. H. D. Rogers.

The latter spoke of the terraces of the St Lawrence and the Lakes. Some of them give evidence that they had been formed by drainings of the upper lakes.

Prof. J. W. Bailey read a paper upon the structure of anthracite coal. He found the evidence of the leaves, &c., in the coal. Thin slices of coal shewed very plainly the vegetable tissue. But there was no evidence that arborescent plants had entered into the formation of coal, it was only the deciduous and soft portions which had been converted into coal. Anthracite coal had alone been examined ; soft coal containing so large a quantity of bitumen could not so readily be tested.

A few remarks passed between Professor Bailey and Mr Teschmacher, upon an apparent discrepancy in their views in relation to the subject of coal.

Professor Hitchcock read a paper, being an attempt to discriminate the animals which had made the fossil footmarks in the Connecticut valley. He had discovered forty-seven species in nineteen localities. At some length, he argued the propriety of his giving names to the birds as well as to the footprints. He then stated the peculiar characteristics of the footmarks which led him to assign the names that he had done, to the birds—such as thick and narrow toes, winged feet, number of toes, absolute and relative length of toe, spread of lateral toes, projection of middle toe beyond the lateral ones, distance between the tips of the lateral toes, distance between the tips of middle and outer toes, direction of hind toe, character of the claw, width of toe, number and length of the phalanges, the impression on the mud, length of step, distance of feet from line of direction, &c. The number of toes varies from three to five.

He explained the means by which to distinguish between the marks of quadrupeds and bipeds, described the classes into which he had divided the birds, and pointed out their affinities. In one specimen which he had found, every alternate step was turned at an angle of 45 degrees from the line of direction. He could explain this only by the conjecture that the animal had broken its leg, and for want of good medical advice the leg was set awry, and this was the cause of the very singular footmark left on the rock. Some giant footsteps, twenty inches in length, he believed to be those of frogs. They resembled closely in character the embryo foot of a frog which had been shewn to him by Professor Agassiz, and here he would remark that the fossils discovered more generally resemble the embryo of animals of the present day than adults.

Wednesday Afternoon.

Professor Horsford, of Harvard University, read a paper, shewing that Barium, Strontium, Lime, and Magnesia, and their salts, are in their intensity in the order of their atomic weights.

Mr E. G. Squier read a paper entitled "Observations on the Fossils, Minerals, Organic Remains, &c., found in the Mounds of the West." Mr Squier stated, that any traveller through the fertile valleys of the west, must have been struck with the number and magnitude of the mounds there existing. Many who have had no opportunity of examining them, have questioned their artificial origin. They have regarded them as the result of diluvial action; and the fact that some of them are stratified, has been seized upon as conclusive upon this point, and as establishing the hypothesis. Recent investigations shew that this feature, instead of being the result of natural causes, is the strongest proof of the artificial origin of the mounds in which it occurs. The tumuli or mounds of the Ohio valley are clearly distinguished from each other by position, structure, and contents. Some are deemed sepulchral; others are connected with the superstitions of the builders; others still the sites of ancient structures, or in some way connected with the military system of the ancient people. The sepulchral mounds stand isolated or in groups, apart from other works; those which are deemed sacred, are found alone within the enclosures. It is this class which appear stratified. They are considerably less in size than the other varieties, and are formed of alternate layers of loam and sand or gravel. The first or outer layer consists of coarse gravel, pebbles, and water-worn stones; the second of loam of variable thickness, alternating with thin strata of fine sand. These layers are all clearly defined, but their arrangement is not uniform. Sometimes there is but a single layer of sand, while occasionally there are as many as six. Pits or excavations, at times broad and deep, almost invariably accompany these works. It is from them that the materials were taken for their construction.

A peculiar feature of these stratified mounds is, that they almost invariably cover altars of burned clay or stone. The altars are generally round, always symmetrical, and are occasionally of great size. One has been discovered sixty feet long, by twelve broad, covered with remains of ancient art.

The character of the stratification fixes its artificial origin. It would be extremely difficult to explain how diluvial action could have originated these altars of burned clay or stone. The mounds of a lower latitude, in Louisiana and Mississippi, present a different kind of stratification. It is not improbable that in some instances natural structures have been modified by art, the natural stratification being preserved.

None of these mounds are found on the first or latest formed terraces of the western rivers, that is, the Ohio or its tributaries. This fact bears directly on the question of their antiquity. The mounds are found indiscriminately upon all the other terraces or bottoms. It is legitimate, then, to conclude, that the latest terrace was formed since the period of their construction. Trees growing upon the works shew that their origin must date back a long period. The forests that cover these works are in no way distinguishable from the other forests. The same varieties of trees are found, in the same proportions; and they have a like primitive aspect. This fact was observed by the late President Harrison, and he considered it one of the strongest evidences in support of the great antiquity of of these works. And here an extract was read from an address made by him before the Historical Society of Ohio.

Within the mounds are found implements, ornaments, sculptures, &c., &c., composed of materials generally foreign to the region in which they are discovered, and often exceedingly rare and beautiful. The identification of the localities from which these were obtained must tend to reflect light upon the origin, migrations, and intercourse of the race of the mounds. Obsidian, a volcanic product, is found in the mounds on the alluvia of the Ohio. The nearest place where it is known to exist in abundance is Central Mexico, the ancient inhabitants of which country applied it to the very purposes for which it was used by the race of the mounds.

In these mounds are discovered native silver and copper from the shores of Lake Superior, pearls and shells from the Southern Gulf, obsidian probably from the volcanic ridges of Mexico, mica from the primitive ranges of the Atlantic coast, galena from the upper, and fossil teeth from the tertiary deposites of the lower Mississippi, besides numberless other remains.

Silver and copper are the only metals which have been developed from the depositions. The ore of lead is quite abundant, and lead, under circumstances, implying a knowledge of its use on the part of the ancient people. No iron, or traces of iron, has been discovered, except in the late deposites, and it is certain that the ancient people were wholly unacquainted with its use.

A mass of native copper weighing twenty-three pounds, from which pieces had evidently been cut, was discovered a few years since in the vicinity of Chillicothe, Ohio. It is nearly certain that both silver and copper were obtained in a native state, and both metals appear to have been wrought in a cold state. They were undoubtedly obtained from the shores of Lake Superior. The copper was frequently wrought into axes, and various other implements, and into ornaments, beads, bracelets, &c. (Several specimens were exhibited displaying a considerable degree of skill in the workmanship.)

The implements and ornaments discovered in the mounds are more generally made of stone; and they wrought the rarest minerals with great skill. Their lance, and armed heads, and cutting implements, were generally made of quartz, and some of them from the pure limpid crystals of this mineral, and some from obsidian. From one altar were taken several bushels of finely wrought spear-heads of milky quartz, nearly all of which had broken up by the fire. In another altar a slight excavation disclosed upwards of 600 spear-heads. "Flint Ridge," which extends through the counties of Jackson, Muskingum, and Licking, Ohio, is a locality in which this mineral is found. The locality appears to have been extensively wrought.

The axes, pestles, &c., like those formerly in use among the existing tribes of Indians, are composed of tough syenitic rocks, greenstone, &c., and are all to be referred to primitive localities.

There are other varieties of rock, a description of compact slate of a dull green ground, interpersed with stripes of a dark black colour, a stone of a high specific gravity, dark ground, thickly interspersed with minute flakes of salmon-coloured mica. The primitive locality of neither of these varieties is known. The most interesting variety of stone is a kind of porphyry, which was wrought into the most delicate ancient sculptures. All the examples were of intense hardness. The primitive locality is unknown.

Mica is found in great abundance in the mounds. It is frequently found in large sheets of all varieties, and is often cut into ornamental figures, discs, scrolls, and oval plates. Some of these plates are quite large. Several fine specimens of graphic mica in oval plates were recently found in a mound near Lower Sandusky, Ohio.

Articles made of other varieties of stone are also found.

Beads and other ornaments are taken from the mounds, composed of the compact portions of marine shells, and several thousands often accompany a single skeleton. Not less than five kinds of marine shells have been fully identified. Quantities of pearls, more or less burned, have been discovered, and they are clearly not from the fresh water mollusca. These must have been obtained from the Gulf of Mexico. The teeth of the shark, alligator, bear, panther, wolf, the talons of rapacious birds, and the fossil teeth of the shark, are taken from the mounds.

The carvings on stone, as before observed, display no inconsiderable skill. They exhibit a close observance of nature, and an attention to details which is not looked for among a people not considerably advanced in the arts. They are remarkable for their truthfulness; they display not only the general form and features of the animal sought to be represented, but to a surprising degree their characteristic attributes and expression. In some instances their very habits are represented.

Among the sculptures are also some of the human head, which, it may safely be concluded, display not only the characteristic features of the ancient people, but also their modes of adjusting their hair, their style of ornament, &c. The skeletons belong to two eras, those of the tribes inhabiting the country when discovered by the Europeans, and those of the builders of the mounds. The skeletons are so much decayed that it is impossible to recover an entire specimen ; but one skull was secured whole.

None of the skeletons are of extraordinary size, although the bones in some cases seem more massive than usual. Specimens of the carvings, &c., were exhibited, which, as Mr Squier observed, displayed no inconsiderable skill and taste.

Professor Agassiz made a communication on the structure and development of Polypi. He was of the opinion that there was a more intimate relation than had been supposed among the radiated animals. He endeavoured to shew the bilateral character of the Polypi.

Mr Dana, of the United States Exploring Expedition, mentioned one or two facts in corroboration of the views of Professor Agassiz.

Thursday's Proceedings.

Dr J. C. Warren made a communication upon the subject of the Mastodon. He at first gave an historical account of the discovery of the different skeletons now existing. He shewed that the Mastodon and Elephant belonged to the same family of Pachydermata or thick-skinned animals. The proper name is Mastodon giganteus. In the skeleton of this animal the great preponderance of the anterior parts is to be observed, the head, tusks, and vertebræ of the neck. The posterior portions of the animal are greatly inferior in size to the anterior. The head of the Mastodon is greatly flattened on its upper surface, differing in this respect widely from the head of the Elephant, the facial angle is smaller than in the Elephant, the cavity of the cranium is smaller. The difference between the teeth of the Elephant and Mastodon were explained, and the growth of the teeth commented upon. It was shewn that the teeth did not all grow at one time, but at different periods. He also pointed out other peculiarities and distinctions. The perfect state in which the bones are found, he attributed to their exclusion from atmospheric air. Their antiquity he could not pretend to detail, but it must be very great.

Professor Agassiz made a remark or two in relation to the subject.

Dr Warren said that some persons had attempted to make out thirty species of Mastodons. He had been enabled to make out only three—the Angustideus, the Humboldteus, and the Giganteus.

Mr Dana read a paper upon the laws or cohesive attraction, as exemplified in crystallization. The following are the inferences which he drew:—

1. Cohesive attraction is characterised by fixed angles, as regards the direction of its action, and by specific relations of force in certain axial directions, and it differs in those particulars for different substances.

2. In the aggregation of molecules by attraction, only equal or homologous axes unite.

3. The axes of cohesive attraction in molecules have opposite polarity at opposite extremities—that is, the opposite poles are positive and negative, or north and south, as the terms are ordinarily used.

4. The polarity of the molecules may be reversed by extrinsic influences.

5. The axes and polarity of cohesive attraction in solidification exist before the union of the molecules, instead of being a consequence of that union.

6. The axial lines of cohesive attraction are not indefinitely fixed in position, but in some way modified in direction and force by temperature.

7. The variations which the attraction of cohesion undergoes, take place according to some simple ratio.

8. The homologous parts of molecules similarly and simultaneously undergo this variation as regards the attraction.

9. In some cases the parts of a molecule or opposite sides of a pole, undergo a different amount of variation. This takes place symmetrically with regard to all the poles.

10. If the state of attraction which produces a primary cube or prism is considered in its normal state, when secondary planes are produced, there is a decrease of force in the direction of the principal axis, and this decrease is in some simple ratio.

11. The diminution of attracting force in the primary axis, on which the formation of a secondary depends, consists in the partial action of their force along intermediate axes symmetrically situated with reference to primary axes; and the greater or less amount of diminution determines the kind of distribution.

12. The direction of cleavage may indicate in any species of matter which set of axes is dominant or strongest in attracting force, the primary or secondary set.

13. Those variations of attraction producing secondary forms, depend often on surrounding bodies favouring the concentration or diffusion of the attracting force, and causes often act simultaneously in nature over wide areas.

14. In an enlarging crystal one axis (or two) may have the action of attraction accelerated by extrinsic influence, and this acceleration or retardation affects equally all crystals forming together under the common circumstances.

15. The action of cohesive attraction is often intermitted, producing seriate results, as exemplified in the cleavage of crystals, and the specific rate of intermittent action is different for unequal axis.

A letter was received from President Everett, inviting the Association to hold its next annual meeting at the University in Cambridge. The invitation was declined for the coming year, and on motion, a vote of thanks was tendered, with the intimation that the Association would accept it at some future day. The reason that the Association declined the invitation was, that it was not deemed advisable to hold two consecutive meetings at or near the same locality. It was then resolved that the next annual meeting should be held in Philadelphia.

A second letter was received from President Everett, covering a letter to him from Mr Bond of the Observatory, communicating the pleasing intelligence that the Nebulæ in the constellation of Orion had been resolved by the Cambridge telescope. The observations were made on Thursday morning, at about three o'clock, and under the most favourable circumstances. Professor Pierce of Harvard University, made a communication upon the subject of the "Nebular Hypothesis." He did not think that its three supports, derived from geology (and of this he did not speak), from physical astronomy, and from celestial mechanics, were sufficient to sustain it. As grand an hypothesis as it is, it must give way to scientific investigation.

Dr J. Wyman, made a report on some crania and bones belonging to a new species of Orang recently discovered by Dr T. S. Savage, in West Africa. Some of the peculiarities of its organization, by which it is readily distinguished from other members of the same family were pointed out; and the different parts of the skeleton were compared with the corresponding ones of the human body.

A detailed account of its habits, drawn up by Dr Savage, was read, giving many interesting facts with regard to its food, to the superstitions entertained by the natives with regard to its nature, &c. This species is much larger than the one heretofore described as coming from the same country. The skull is two inches longer than that of an ordinary man.

In the afternoon, Professor Bailey exhibited some fossils from the coal-formation in New Mexico, New England, from Santa Fe, and near the Rocky Mountains. They were sent to him by Lieut. Abert of the United States Army. Professor Agassiz made a verbal report on the geographical distribution of animals along the coasts of New England. He said that this was a difficult subject for investigation—the data to be collected are few—and it involves the question, where did the animals originate, and where do they live? They are capable of locomotion, and the actual distribution is not the primitive distribution. The general result may be arrived at, that the animals are different in different localities.

Wild animals differ in small areas—different geographical divisions are inhabited by different animals. The Arctic animals are identical in all parts of the world. As you approach to the more temperate and tropical regions, the animals of different localities differ more widely. Sometimes, however, similar or analogous species are found. The fresh-water fish originated in the localities where they are found. These fish are entirely different in different countries; and those species which now appear identical will, the Professor thinks, one day be determined to be unlike in their structure and character. One of the grand results shewn by the naturalists of the Exploring Expedition is, that the land-shells of the islands in the Pacific Ocean are entirely different in different islands; each island appears to have a species of shell peculiar to its own formation. These shells could not have been derived from the continent, but must have originated on the respective islands where they are found. The geographical distribution is connected with the features of a country; as, for instance, the monkey tribe is confined to the tropics. The fossils of New Holland and of Brazil belong to the same families of animals that now inhabit these countries; this fact shewing that the same laws prevailed before man had anything to do with the geographical distribution of animals, as prevail at the present time. The geographical distribution indicates the primitive origin. The higher organised beings are found in the higher climates; the lower organization in colder climates. The Alligator, the highest organization of the reptile family, is found alone in the tropics. Frogs exist only in cold regions, and so of other animals and reptiles. The monkey, which possesses of all other animals the strongest affinities to man, is confined to the tropics. As the new species of the monkey tribe, which had been described by Dr Wyman, lives in the land of the Negroes; and as they claim affinity to it, Professor Agassiz was inclined to think that the negro has a more intimate connection with the country where he lives than is generally admitted. The fact that the lowest terrestrial mammalia (the Pachydermata) are found in the tropics, may seem to contradict the position that the nearer the approach to the higher regions, the higher the organization. But these mammalia are the remnants of ancient races of animals. The shells and fishes of the shores of Massachusetts have been treated in an able manner by Drs Gould and Storer. But the Radiated animals and the Crustacea have been almost entirely neglected. The latitude in which an animal is found must not only be considered, but also the depth of water at which it lives; and this because the conditions of existence are different at different depths. The same species do not live in shallow and deep water. A very few feet below low-water mark the species differ greatly from those above it. And this small difference between low and high water mark corresponds to several thousand feet in height in the diffusion of terrestrial animals above the level of the sea. The types also vary as you descend down to the depth of eight or nine fathoms; so that there are as it were levels, where the animals found in the separate levels differ entirely from those in the levels immediately above and below. The Professor thought it singular that the different depths at which various kinds of fish are caught, had never called the attention of naturalists to the habits, &c. of the lower class of animals inhabiting the water at different levels of the ocean.

Professor Adams mentioned the existence of a singular pond on the Peninsula, at Port Royal. Two different types of animals exist in the pond, one 18 inches below the surface, the other some two feet or more below the surface; the line of demarcation between them is perfectly distinct.

A few remarks were made upon the subject by Dr Holbroke of Charleston, South Carolina.

Professor Agassiz said that the same species of fish were found in the head waters of the Rhine, the Rhone, and the Danube; and that there was no communication between the basins of the three rivers. The same species had also been found in the mountain rivers of Norway and Sweden. These facts shew that one species is not confined alone to one basin or series of basins.

A paper was read by Dr Dickeson, on the Cypress Basins of Louisiana and Mississippi. He spoke of the geographical distribution of the cypress—the habits of the tree. It runs parallel with the cotton plant. But a small proportion of the wood is available for mechanical purposes. But little can be transported to market, as the specific gravity is greater than that of water. The cypress growing along the bayous is of an inferior character; that growing along the Mississippi river is a much better wood. There are remains of cypress stumps which must be at least 4000 years old. In the texture and quality of thes wood there is great variety.

A letter was read from George G. Smith, extending an invitation to the members to attend the fair of the Charitable Mechanics' Institution. A letter was also read from Moses Kimball, giving the members an invitation to visit the Boston Museum.

Professor H. E. Rogers read extracts from a report made by Lieutenant Maury, and presented to the Association a chart, shewing the currents of the Northern Atlantic Ocean. The publication of these charts is to be continued, shewing the currents in other parts of the Atlantic and in the Pacific oceans. The hope was expressed that these charts would enable navigators to make their voyages in shorter times, and with less labour and difficulty, than is done now.

In the evening, the Association met at half-past seven o'clock, and a paper was read by Dr Prescott upon the fishes found in Lake Winnepissiogee and its tributary waters.

Dr Storer made a remark or two upon this paper.

A communication was made upon the subject of concretions by Professor Adams.

Remarks upon this subject were made by Professors Haldeman and Johnson of Pennsylvania.

The Association adjourned at nine o'clock P. M., to accept an invitation extended by Dr Warren to the members to call upon him socially at his residence. The Association has visited several of our hospitable citizens since the commencement of the meetings in this city.

Friday's Proceedings.

A paper by Dr N. D. Gale, upon the Natchez Bluff Formation, was read by the secretary, Dr Wyman. This Natchez Bluff is among the latest formations; there is none other within fifty or sixty miles of it later than this. It consists of beds of gravel, sand, and loam. The gravel is composed of coarse pebbles near the base; the pebbles decrease as you approach the sand-bed. This is the deepest; in some places from 60 to 100 feet thick. The fossils in the gravel bed were described. They are silicified, and belong to the older secondary rocks, and are transported from distant geological fields. Many of the specimens are worn to rounded pebbles, having received this form by being transported by the currents. The fossils of the other beds were also described. The Mastodon is found *in*, not *upon*, the loam bed.

Professor W. B. Rogers remarked, in connection with the observations of the preceding paper, that the subject of the transporting power of water in the force of rivers, currents, waves, &c., is one which as yet stands in need of experimental investigation. We have yet, indeed, no accurate data on the subject, and it would form a most important contribution to geological science, were the power of aqueous transportation really ascertained in numerical force. No statements on this subject can be relied upon which do not take into account as well the force and nature of the surface upon which the matter is moved, as the velocity of the current and the size and specific gravity of the transported materials. Professor Rogers urged the investigation of the subject *systematically*, as a most important basis for much geological reasoning.

Professor Agassiz said, that the rate of currents, as transporting agents, was not accurately ascertained. There were no data to determine the transporting power of the agent or currents which transported the boulders and drift. But the data of the glacier movements have been accurately determined.

Mr Dana stated that publications had appeared in England, shewing the velocity of water; but the deductions arrived at were on mathematical and not experimental grounds.

Professor Agassiz said, that in the early history of glaciers their movements were explained on mathematical grounds; but experiment had shewn that the whole matter was erroneous.

Professor W. B. Rogers gave an abstract of a series of researches lately made by himself and Professor R. D. Rogers, on the absorption of carbonic acid by liquids. Their researches, besides applying to most of the liquids *included* in the well-known experiments of Saussure, embrace many others. The method of research involving a peculiar apparatus for securing permanency of temperature and moisture, is entirely new, and is regarded as capable of very great accuracy, while it has the further advantage of being applicable to many variety of liquids, as well as to solid bodies. It furnishes a complete result in a few minutes, while the method hitherto in use, in many cases, requires several days.

The results they obtained vary greatly from the determinations of Saussure, which have heretofore been relied on as accurate. Among these, Professor Rogers mentioned, as a very interesting fact, that common sulphuric acid, at 60° degrees of Fahrenheit, absorbs carbonic acid in the enormous proportion of 94 per cent., and that Nordhausen acid absorbs 125 parts to the 100 of liquid. Professor Rogers especially insisted on the importance of this fact on its bearings on the processes for determining the amount of carbonic acid in the free atmosphere, as in the experiments of Boussingault and others, and that in the air of mines, and the air escaping from the lungs in respiration. The use of the sulphuric acid as a drying agent in these processes, as well as in the apparatus of Fresinius for analyzing the carbonates, was thus shewn to be attended with serious error, in consequence of the absorption of the carbonic acid by the dessicating agent.

A conversation took place, in which Professor Agassiz, Professor Johnson, and Mr Teschmacher engaged. The latter remarked, that he hoped in his future experiments Professor Rogers would consider the connection of this subject with an atmosphere of carbonic acid gas during the coal period, and its then action on the disintegration of rocks.

Professor S. S. Haldeman read a paper upon the languages of the Aborigines of the South-West. The labials, the easiest sounded of all the letters, are wanting in the Indian languages ; the want of these sounds is a marked peculiarity of these languages. The Professor thought that he had identified a peculiar sound of the Arabic with some of the sounds of the Indian languages. The Wyandotts close the glottis after pronouncing the vowels ; the North-Western after pronouncing the consonants. The Cherokees place the final accent on almost every word. There is no word for horse among the South-Western Indians. Other differences and peculiarities were pointed out by Professor Haldeman.

A brief discussion sprang up relative to the time allowed for making written and verbal reports, and several motions were made, but subsequently withdrawn.

Professor B. Silliman jun. laid before the Association the prospectus of the Ray Society.

Professor Henry made a few remarks on the plan of the Smithsonian Institute.

Dr Dickeson read a paper on the mounds of the South-West. These mounds are very similar in character to those found in the Ohio valley ; many articles found in them are identical with those discovered in the Ohio mounds. Dr Dickeson has opened a large number of these mounds, and recovered from them great quantities of ancient relics. It is generally believed that the Indians are ignorant of the purposes for which these mounds are built. They always declare their ignorance when questioned in relation to them. But it is well known to the citizens of the South-Western States, that they visit them in the most mysterious manner to the present day. They invariably follow the ancient paths when visiting them, unless obstructed by works of improvement. They can trace the paths with the greatest accuracy, even after the plough has passed over the field. They usually leave the mounds about midnight, making the most hideous howls and groans. Ovens have been discovered in the mounds of Arkansas, with the pottery in them all ready for baking. A head was discovered with artificial teeth set.

As we gave in our paper of yesterday so full a report of the paper made by Mr Squier, we have not thought it necessary to do more than mention a few facts related by Dr Dickeson, more especially, as there is so strong a resemblance between the mounds of the Ohio valley and the South-West, and in the articles recovered from them.

Mr Squier remarked, that there was an almost absolute identity existing between them.

Professor Hall made a communication, being the general results of investigation in the palæontology of the lower strata of New York.

Professor Agassiz remarked, that the types for this country should not be taken from the European formations. The men of science in this country have no cause to fear their European brethren; they have made more progress in the same departments than the scientific men of Europe. It must be a source of congratulation with them, that this country must furnish the principal geological types.

Professor H. D. Rogers remarked, that each country or district must be a type for itself; that one geological formation could not be a type for another in a remote region of country, that is, it would not do to extend the types.

Professor H. D. Rogers offered some remarks on the reorganization of the Association.

Professor Agassiz gave a brief account of similar Associations in Europe, and more especially of the Swiss Association, the parent of all the others.

Brief remarks were made by other members upon the reorganization of the Association. It was then voted that the Association should be designated as the "American Association for the Promotion of Science."

A paper was read by Professor C. B. Adams on the Taconic system of rocks.

The Secretary read a paper on the same subject by L. Vanuxen.

Professor S. S. Haldeman made a report on the character of *Triarthus Bekkii* and *Atops Trilineatus.*

In the evening Mr Hodge made a few remarks on the *economical* geology of Berkshire.

M. Desor read a report on the Drift of New England. As the views were mainly those offered by this gentleman a few days since, when a kindred subject was under discussion, and as we then made a brief abstract of the same, we shall make no report of the remarks presented by him on Friday evening. M. Desor sustains the glacial theory.

Remarks were made on the subject of M. Desor's report by Professors H. D. Rogers and Agassiz. Professor Rogers also made a report on the Drift of New England. He differs from M. Desor in his views of the same. Professor Rogers is an advocate of the diluvial theory.

On the Zeuglodon—Koch's Hydrarchos.

The recent publication of a report by Carus of Dresden, on these interesting remains, has again called attention to the controversy with regard to their true nature. The main points in dispute are two:—

I. As to the fact of the bones belonging to one and the same individual.

II. As to the nature of the animal, whether a Reptile or a Mammal.

I. Mr Koch avowed that the bones all belonged to one and the same individual—that they were found in one locality, and very nearly in their natural order. Dr Gescheidt of New York, after examining the skeleton, maintained that this statement was correct, as is obvious from the following paragraph—

" Having by this, as shortly as possible, proved that the vertebral column of the Hydrarchos is not composed of different vertebræ, but is a whole and an integral part of a fossil animal, &c."

Carus of Dresden, relying upon Koch's statement, entertains the same view.

On the other hand, it was denied that the vertebral column above mentioned did belong to one and the same individual, because the bones of which it was made up presented different degrees of ossification, some of the bones being in a mature, and others in an immature, condition ; a state of things never occurring in one and the same animal.

This conclusion is supported by the testimony of those who were eye-witnesses of, or familiar with, the exhumation of the remains. Dr Lister, who resides in the immediate neighbourhood of the locality where the bones were found, but was not an eye-witness of the exhumation, says :—" They were not lying in their natural position, so as to constitute an unbroken series, but were scattered here and there ; others were procured in Clark county, twenty miles distant."

Mr Lyell, whose accuracy and love of truth no one will question, travelled over the region of the Zeuglodon, and, in a letter to Professor Silliman jun., states as follows :—

" Part of the head of the Zeuglodon and vertebræ, extending to a length of thirty feet (the Hydrarchos was one hundred and fourteen feet), were procured by Mr Koch, in 1845, at a place which I visited, four and a half miles southwest of Clarkville, Ala., in company with Mr Pickett, who assisted in the exhumation made by Mr Koch ; but the main body of the vertebræ (as I learn from the same gentleman and *other persons*) which entered into the skeleton exhibited in the United States under the name of Hydrarchos, were procured in Washington county, fifteen miles distant, in a direct line from the place where the head was discovered." (See *American Journal of Science*, vol. i., p. 312, *New Series.)*

The editors insert as a note to the preceding, the following :—

" Another correspondent, S. G. Houston, Esq., gave us a confirmation of Mr Lyell's statement. Mr H. says that the fossils were found, a bone here and a bone there, scattered over a space of twenty-five miles."

Mr Koch has not brought forward the testimony of a single eye-witness in corroboration of his own statement.

II. Mr Koch maintained that the bones were those of a Reptile (" Sea Serpent"). Dr Gescheidt rejected the idea that they were those of a serpent, but maintained their reptilian character, " a connecting link between Saurians and Mammalia." Carus of Dresden, in his recently published memoir, entertains the reptilian view, and, in accordance with it, has given an ideal diagram of a restored head, in which the reptilian character is strongly portrayed.

On the other hand, it was maintained that it had no character whatever of a reptile. No reptile has as yet been discovered having teeth with double roots implanted in corresponding sockets; the Hydrarchos has teeth with double roots and double sockets. In reptiles the bodies of the vertebræ are either concave on one face and convex on the other, or else doubly concave; the faces of the vertebræ of the Hydrarchos are flat as in mammalia. The size of the vertebral canal compared with the bodies, has, in the Hydrarchos, the Mammalian and not the Reptilian proportions.

If any doubt heretofore existed, it is now removed by the recent discovery by F. S. Holmes, Esq., and Professor Lewis R. Gibbs, of Charleston, South Carolina, of a skin of the Zeuglodon nearly entire, and which demonstrates that the restored head given by Carus is purely imaginary (and with this statement any one will be satisfied who will take the trouble to compare the figures). The newly discovered skull, in addition to the character given above, has the double occipital condyles, only met with in Mammalia, and the convoluted tympanic bones which are characteristic of Cetaceans. (See *American Journal of Science, September* 1847). The bones of Koch's Zeuglodon are now in Berlin, and a report on them is in preparation, to be presented to the Academy of Sciences by Professor Muller, the most distinguished German physiologist. In a letter to Retzius of Stockholm, recently published, he says,—"I think I can satisfactorily shew that the Hydrarchos is not a reptile, but a mammal belonging to a peculiar extinct family. It has the ear formed as in the mammals, viz. :—a helix constructed as in the mammalia, with a tympanic bone as in the whale. It has, moreover, two occipital condyles, and, in the whole formation of the cranium no trace of a reptile structure occurs, but, on the contrary, everything is as in the mammals."

From this review of the evidence in the case, the two following propositions, given in a former report, are sustained.

1*st*, The skeleton of the Hydrarchos is composed of bones belonging to two different individuals.

2*d*, The bones are those of a Mammal. In addition to the above, it may now be added,

3*d*, That they are intimately allied to those of Cetaceans. —J. W. (*Boston Journal, September* 30, 1847.)

On the Malayan and Polynesian Languages and Races. By JOHN CRAWFURD, Esq., F.R.S.L., Conductor of the Embassy to Siam. Communicated by the Ethnological Society for Edinburgh New Philosophical Journal.*

Distinct and unequivocal traces of a Malayan† language have been found from Madagascar to Easter Island, and from Formosa to New Zealand, over 70 degrees of latitude, and 200 of longitude.

To account for this remarkable dissemination of a language, singular for its extent, among a people so rude, it has been imagined that all the tribes within the wide bounds referred to constitute, with the exception, however, of the Papuas or Negroes, one and the same race, and that the many tongues now known to be spoken by them, were, originally, one language, broken down, by time and dispersion, into many dialects. This is the theory adopted by Mr Marsden, Sir Stamford Raffles, and the Baron William Humboldt, as well as by many French and German writers, but I believe it to be wholly destitute of foundation.

A sketch of the different groups of nations within the range I have alluded to, will shew, that whether their languages be of one stock or not, the men themselves belong physically to distinct races. They may, I think, be divided into three groups—men of brown complexion, with lank hair; men of sooty complexion, with woolly hair; and men of brown complexion, with frizzled hair. Each of these, again, consists of several subdivisions.

Beginning with the first group, the most remarkable race in it is what may be called the Malay. The prevailing complexion is here a light brown, with a yellow tinge; the hair is lank, long, coarse, abundant on the head, and defective on every other part of the body; the nose is short and small, but never flat; the mouth is large; the lips thin; the cheek-bones high. The person is squat, and the average stature does not exceed 5 feet 3 or 4 inches.

* Read before the Ethnological Section of British Association, June 1847.

† I use this word as a common term for all that belongs to the Archipelago.

This is the only race, within the bounds described, that has exhibited a considerable intellectual development. It has, for ages, possessed the knowledge of letters, worked the useful metals, and domesticated useful animals. Judging by the evidence of language, these arts are of native growth, and not borrowed from strangers.

All the inhabitants of Java, Sumatra, Borneo, Celebes, Bali, Lonbok, and Sumbawa, are of this race, as are most of those of the Malayan Peninsula, and of the Philippine Islands.

East of Celebes and Sumbawa, and lying between these and New Guinea, there is a second division of men of brown complexion and lank hair, constituting, probably, a distinct race. The stature is the same as in the last, but the complexion is darker, the features generally coarser, the lips thicker, and the hair often buckling or even frizzling, so as to give them an appearance of being an intermediate race between the lank and woolly haired families. The inhabitants of Flores, Gilolo, Timur, the Molunas, and several smaller islands, would seem to belong to this race, who, although they have made considerable progress in the arts, have never invented the use of letters. The inhabitants of Gueby, an island lying between Gilolo and New Guinea, may be taken as a fair example. M. Freycinet describes them as being of a dark olive complexion, with flat noses, projecting lips, and a facial angle of seventy-seven degrees, which is from ten to twelve degrees higher than that of the oriental negro of the same neighbourhood.

The inhabitants of the Caroline, the Marianne or Ladrone, and Pelew Islands, probably constitute a third subdivision of the brown-complexioned and lank-haired people. The average height of five individuals, as taken by Freycinet* and his companions, was 5 feet 7 inches English. This would make them much taller than the Malay race, but probably the height is over-rated, from the average being taken from too small a number of individuals.

Passing over countries inhabited by negro races, and en-

* Voyage autour du Monde. Paris, 1829.

tering the Pacific, we first encounter a race with brown complexion and lank hair in the group of the Feejee and Friendly Islands, in about 180° of east longitude. The same race constitutes the inhabitants of the Society, the Marquesas, the Lowe Islands, the Navigator Islands, Easter Island, and New Zealand, with the Sandwich Islands.

Although dispersed over little less than sixty degrees of latitude, and eighty of longitude, the inhabitants of all these islands speak essentially the same language, and approach so near to each other in form, that they must be considered as one race.

In respect to stature, however, there is either some difference between them, or there is some discrepancy in the accounts rendered of it by voyagers; yet it is not material. Freycinet makes the inhabitants of Tahiti 5 feet 8 inches, and those of the Sandwich Islands 5 feet 9 inches high. This is about the ordinary stature of Europeans. Cook, who describes the people of the Marquesas as the handsomest of all the South Sea islanders, makes their average height from 5 feet 10 to 6 feet, which is making them some 3 inches taller than Europeans.

La Perouse makes the inhabitants of the Navigator Islands from 6 feet and 1 inch to 6 feet and 2 inches high; but he admits that he measured individuals not exceeding 5 feet 8 inches. He describes them as being equally powerful and athletic as tall, and concludes that, compared with Europeans, they are as the Danish horse to the ordinary one of the French provinces. There is no doubt, however, some exaggeration here; for Captain Wilkes, in his recent voyage, makes their stature only 5 feet 10 inches, and says nothing of their superior strength.*

The other physical features of this race are given by Freycinet and Cook. The first describes the Sandwich islanders as having oval faces, noses a little flattened, small black eyes, large mouths, projecting lips, long lank hair, a little frizzled, very little beard, and a complexion of a clear brown.

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* Narrative of the United States Exploring Expedition. London, 1847.

Cook says of their colour that it is a "nut-brown," and that "it would be difficult to make a nearer comparison, taking in all the different lines of that colour."

In so far, then, as physical form is concerned, there can, I think, be little doubt that this race, so tall and well-proportioned, is a very distinct one from the short and squat Malay, from which it has been gratuitously imagined to be derived.

The varieties of the Negro race, within the scope under consideration, are more numerous than those of the brown-complexioned. They have been usually called Papua, which is the corruption of a Malay adjective meaning "frizzled." Some writers have also called them Austral Negroes, evidently an improper appellation, as they are found equally in the northern as the southern hemisphere. Perhaps the name Oriental Negro is more suitable, but the name Negritos, or Little Negroes, applied to them by the Spaniards, is still better.

Beginning from the west, we first find a race of oriental negroes occupying the whole chain of the Andaman Islands, in the Bay of Bengal, between the 10° and 14° of N. latitude. This is a diminutive squat being, not exceeding 5 feet high, of a sooty-black colour, with flat nose, thick lips, and short woolly hair.* Two individuals of this race, whom I saw in Penang, to which they had been brought by the late General Kydd, who had superintended an attempted British settlement on the Andamans, entirely agreed with this account.

Lately, a race of Negroes has been unexpectedly discovered in the interior of the Nicobar Islands, hitherto believed to have been wholly occupied by the Malay race, but I have seen no account of their personal appearance.

We find a negro race next in the mountain-chain which runs through the length of the Malay Peninsula. This is known to the Malays, in some parts, under the name of Sámang, and in others of Bila. Those people are of a sooty-black complexion, have woolly hair, and African features. An adult male, measured by my friend General Macinnes,

* Syme's Embassy to Ava. 1800.

was found to be only 4 feet 9 inches high. This individual was brought from the mountains of Queda. A lad sent to myself, while in the administration of Singapore, by the Raja of Kálanten, a Malay state on the east coast of the peninsula, agreed in complexion, hair, and features, with the description now given.

The great islands of Sumatra, Java, Borneo, and Celebes, are without any negro race of inhabitants; nor is there any record or tradition of them ever having existed. In some islands of the Philippine group, however, they are found in considerable numbers, and are well known to the Spaniards under the name of *Negritos*. Zuñigas' description of them is, that they are more of a copper colour than the true African negro, that they have flat noses, soft hair, and are of very low stature. The total number of them subject to the Spanish rule, in the principal island of Luçon, is about 3000.

From all those accounts, I am disposed to conclude, that the negroes of the Andaman Islands, probably those of the Nicobars, those of the Malayan Peninsula, and of the Philippine Islands, are all of the same race, which would include all the negroes north of the equator. But it must be admitted that this conclusion may not be warranted by a better knowledge than we now possess.

South of the equator, and still within the Malayan Archipelago, we find at least two races of negroes on New Guinea and the islets adjacent to it. One of these has the Negro features, but not in an exaggerated form; and the hair, instead of growing in woolly tufts, is frizzled, long, and bushy, so as to be easily dressed out into the huge mop-like form, of which good representations will be found in the plates annexed to the voyages of the recent French circumnavigators. The stature appears to be about the ordinary one of the Malayan race.

Sir Stamford Raffles brought to England a lad of ten years of age, a native of New Guinea, of the woolly-haired race, of which there is a good representation in the second volume of his History of Java. The late Sir Everard Home described this individual as follows:—" The Papuan differs from the African negro in the following particulars: His skin is of a lighter colour. The woolly hair grows in small tufts, and each hair has a spiral twist. The forehead rises higher, and the hindhead is not so much cut off. The nose projects more from the face. The upper lip is longer and more prominent. The lower lip projects forward from the lower jaw to such an extent that the chin forms no part of the face, the lower part of which is formed by the mouth. The buttocks are so much lower than in the Negro, as to form a striking mark of distinction, but the calf of the leg is as high as in the Negro."*

Both races appear to exist on the island of Wagiou, lying immediately at the north-west end of New Guinea, and most probably there has been here some intermixture of them. M. Duperry, in the voyage of the Coquille, gives the following description of the inhabitants of this island:—" They are of slender and delicate person, and generally small. Of twenty individuals measured, one only was found to be as much as 5 feet 6 inches high. The average gave only 5 feet 4 inches. In complexion they were less black than the inhabitants of New Ireland, and their features were more regular and agreeable. The facial angle was from 63° to 69°. In some the hair was woolly, like that of the African negro; in some it was lank; and in others intermediate between the two."

After passing New Guinea, we find all the islands lying east of it and of New Holland, up to 170° of east longitude, and from the equator to the tropic of Capricorn, inhabited by men of the Negro stamp, and, as far as they are known, differing so much from each other as to seem to constitute distinct races.

In the voyage of the Coquille, the inhabitants of New Ireland are described as being, in stature, from 5 feet 5 to 5 feet 6 inches, with persons rather slender than athletic—of a colour less black than the African negro, having a facial angle of 66 degrees, and woolly hair, with little beard. They were an uglier race than the inhabitants of Wagiou, within the Archipelago.

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* History of Java, by Sir Stamford Raffles, vol. ii.

Cook describes the inhabitants of Malicolo and of the New Hebrides as a very dark-coloured and diminutive race, with long heads, flat faces, and monkey countenances; their hair as black, short, and curly, but not quite so short and woolly as that of the African negro, and their beard as short, crisp, and bushy. He pronounces them "an ape-like people," and the most ugly and ill-proportioned he had encountered in the Pacific; "quite a different nation from any other" he had met with in that sea.

Cook's account of Tanna, another of the New Hebrides, makes the inhabitants short and slender, but with good features, and agreeable countenances, having hair crisp and woolly, but longer than that of the inhabitants of Malicolo. At first he was disposed to think them a mixed race between the latter and the Friendly Islanders, but a little acquaintance convinced him they had "little affinity with either."

The isolated New Caledonia, lying between the 20° of south latitude and the tropic, is inhabited by another race of negroes, plainly differing from those already mentioned. Cook describes them as a strong, robust people, some individuals being found as tall as 6 feet 4 inches. Their colour is the same as that of the inhabitants of Tanna, that is black, but not an ebony black. They had, however, "better features and more agreeable countenances." "I observed," says he, "some who had thick lips, flat noses, and full cheeks, and, in some degree, the features and look of a negro." The hair he mentions as very much frizzled, so that, at first, it appeared much like that of an African negro, yet was "nevertheless very different." The hair, in fact, appears to be of the same texture as that of some of the inhabitants of New Guinea, and was, like that of these, easily dressed into a hideous mop, as already described.

But we have still another race in the inhabitants of the islands of Torres Straits. Mr Jukes describes the inhabitants of Erroob as follows:—"The men were fine, active, well-made fellows, rather above the middle height, of a dark-brown or chocolate colour. They had, frequently, almost handsome faces, aquiline noses, rather broad about the nostrils, well-shaped heads, and many had a singular Jewish cast of features, The hair was frizzled, and dressed into long ringlets. The hair of their body and limbs grew in small tufts, giving the skin a slightly woolly appearance."*

The Australian continent, with Van Diemen's Land, may be considered as coming within the scope of the present inquiry. The Australian approaches nearer to some of the oriental negroes than to any other races of mankind, but is, notwithstanding, widely different. One race occupies the whole continent. Its average stature is 5 feet 6 inches, and the colour "almost black." The hair is black, sometimes lank, and sometimes curled, but never woolly. The beard is tolerably abundant and long. The mouth is large, the lips thick, the teeth good, but frequently there is no distinction in the form of the incisors and canine. "Compared with the other races scattered over the face of the globe, the New Hollander appears to stand alone."†

It remains only to notice the inhabitants of Madagascar, very wantonly imagined by some writers to be of the Malayan race, simply because in the Malagasi language there have been found a few words of a Malayan tongue. But the people of Madagascar, whether Hovas or ordinary Malagasis, are merely a variety of the African negro, and, neither in colour, features, form, or stature, do they bear any analogy either to the Malayan race, or to any section of the oriental negro.

From the enumeration now made, it will appear that there are no fewer than five distinct races of the brown-complexioned and lank-haired family; and, without including Madagascar or Australia, and supposing all those to the north of the equator to be identical, not less than eight of that of the oriental negro. As far, then, as physical form is concerned, it is certain enough that none of these widely scattered races could have sprung from one and the same stock, as has been imagined; yet, in most of the many tongues

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* Narrative of the Surveying Voyage of the Fly. London, 1847.

† Journal of Expeditions of Discovery into Central Australia, by Edward John Eyre. London, 1845. Discoveries in Australia, by J. Scot Stokes, Conr. in the R. R. 1846.

spoken by them, whether brown or negro, traces of a Malayan language are to be found.

A brief examination, phonetically, grammatically, and verbally, of some of the principal languages, will, I think, clearly shew that they are generally distinct tongues, not derived from a common stock, and that the Malayan words they contain have been engrafted on them as Teutonic words have been on the continental languages of Europe of Latin origin; or as French words have been on our own Anglo-Saxon, although, indeed, the mode by which this has been effected has been, in general, very different.

The languages from which, in my opinion, the words so engrafted have been, for the most part, derived, are those of the two most civilized, numerous, and adventurous nations of the archipelago, the Malays and Javanese. The Malayan words found in each language that has received them will, I think, be found not only numerous, but correct in sound and sense, in proportion to the facilities, geographical, navigable, and lingual, possessed by the parties adopting them, of communication with the parent countries of the Malay and Javanese nations.

The dissemination might be direct from Sumatra and Java, the parent countries in question, or indirectly from some nearer country; and it would happen through commerce, piratical expeditions ending in settlement and conquest, or by the fortuitous wreck of tempest-driven vessels, to all of which I shall, afterwards, more particularly allude.

The Malay and Javanese languages have the same number of vowels, diphthongs, and consonants. The vowels are six in number, viz., *a*, *á*, *e*, *i*, *o*, *u*; the diphthongs two, *ai* and *au*, and the consonants nineteen, *b*, *c̃*, *d*, *'d*, *g*, *j*, *k*, *l*, *m*, *n*, *ṅ*, *ñ*, *p*, *r*, *t*, *'t*, *w*, *y*, exclusive of the aspirate, which never begins a word or syllable, and always follows a vowel.

In no part of speech of either language is gender or number expressed by a change in the form of the word; and the only instance of an inflexion is to express a possessive. Relation is expressed generally by prepositions.

The only changes which verbal roots undergo, express neuter, transitive, casual, passive, and reciprocal verbs; and this is effected by prefixes or affixes, or both together. Time and mode are expressed by modals prefixed.

It is to be observed that the adjectives expressing gender and number, the prepositions expressing relation, the prefixes and affixes applied to verbal roots, and the modals expressing time and mode are, for the most part, different in the two languages, although there be so general an agreement in their grammatical structure.

In these characters, phonetic and grammatical, the other languages of Sumatra, of Java, of Madura, of Bali, of Lomboc, and of Borneo agree, but the similarity goes no farther than these.

I proceed to compare some of the other languages in which Malay and Javanese words are found with those characteristics of the Malay and Javanese languages, and begin with that of Madagascar. Instead of six vowels, this has only four,—*a*, *e*, *i*, and *u*. Instead of nineteen consonants, it has but fourteen, viz., *b*, *d*, *f*, *g*, *k*, *l*, *m*, *n*, *ṅ*, *p*, *v*, *s*, *z*, *zd*. It wants the *c̃*, the palatal *ḋ*, and *ṫ*, *j*, *ñ*, *w*, and *y*, of the Malay and Javanese, but it has *f*, *v*, *z*, and *zd*, which are unknown to these. Like these it has an aspirate; but instead of following the vowel as in them, it always precedes it.

In Malay and Javanese, words may end in a vowel, a consonant, or an aspirate indifferently. In Malagasi, they can end in a vowel only.

In Malay and Javanese, the liquids *l*, *r*, *w*, and *y*, are the only consonants that coalesce with other consonants; but, with the exception of *r* in a few instances, they never do so in Malagasi. On the other hand, we have in this language combinations of consonants unpronounceable by a Malay or Javanese, as *mp*, *nt*, *nzd*, and *ts*, and these, even beginning words and syllables. If the natives of Madagascar had invented an alphabet, which, like other Negro Africans, they have not done, each of these harsh sounds would, probably, have been considered a distinct consonant, and have had its proper character.

But the grammatical structure of the Malagasi has been adduced as proof that it is a member of what has been called the Polynesian family of languages, in itself a mere hypothesis, and the form of the verb has been especially referred to as evidence.

One form of the Malay, but not of the Javanese transitive verb, is made by prefixing to the root the inseparable particle *má*, the nasals *m*, *n*, *ñ*, and *ṅ*, being substituted for the initial letter of the root as the euphony of the language may demand.

There exists also in the Malagasi a verbal prefix beginning with the letter *m*; but beyond this there is no analogy. The Malagasi prefix, instead of being one, expressing one meaning, amounts to thirteen, expressing as many meanings. We have *mi*, *man*, *mana*, *maha*, *mampi*, *mampan*, *mampampan*, *mifan*, *mifampi*, *mifampan*, *mampampan*, and *mampifampan*. Each of the Malagasi verbs formed by these prefixes has an indicative, an imperative, and an infinitive mood. The indicative has, throughout, a present, a preterite, and a future tense expressed by an inflexion. In four kinds of verbs, the imperative has two forms; and in nine, it has four. In all, the root undergoes 180 changes.

There is nothing analogous to this in the simplicity of the Malay or Javanese verbs. To the copious and elaborate Dictionary of Messrs Freeman and Johns, a most meritorious work, there is prefixed the paradigm of a Malagasi verb, from which I have borrowed my representation of it.* The root in this case, is *sulu*, a substitute which, I have no doubt, is the Javanese word *sulur*, meaning the same thing, or "a representative," or "agent," with the loss of its final consonant, indispensable to the genius of Malagasi pronunciation.

The greatest number of changes which any root can be made to undergo in Malay, or Javanese, does not exceed twelve; and *sulur*, the root in question, could not be subjected even to one half this number, not one of which would correspond in sound or sense with any one of the Malagasi compounds.

The very length of these Malagasi compounds appears to me to be good evidence against the allegation that the Malagasi is of Malayan origin. The great majority of Malay and

* A Dictionary of the Malagasi Language, by J. J. Freeman. London, 1835.

Javanese roots are bisyllables; but in the Malagasi they frequently extend to four or even five syllables; and when to these are added, not monosyllabic prefixes or affixes, as in Malay and Javanese, but prefixes or affixes, of two, three, and even of four syllables, the monstrous length of some compounds may readily be supposed. From the root *sulu* already mentioned, although only of two syllables, is formed, for example, the compound *mampifampanolo*, which means, "to order to cause to exchange," being a word of six syllables, of which the languages of the Malayan family afford not one example. But words of even double this length may be formed!

I come now to the evidence afforded by words. The Malagasi Dictionary, already quoted, contains about 8000 words, exclusive of compounds. I have gone carefully over it more than once, and can discover no more than 140 which are of Malayan origin, which would make about $\frac{1}{57}$th part of the language.

But to the dictionary is appended a list of words especially called roots. These amount to 500; and among them I find just six Malayan words, and no more.

The nature of the Malayan words found in the Malagasi, is of much importance in the inquiry. Sixty are the names of natural objects, and thirteen are numerals. There is no preposition among them, no auxiliary verb, nor any other word essential to the structure of a sentence. The language, in a word, might be written or spoken without them, with more ease, and that is not difficult, than good English can be written or spoken without the assistance of the Norman-French portion of it.

The Malayan words received into the Malagasi are, with with few exceptions, corrupted in sound, a result to be expected from the wide difference between the phonetic character of the languages. The corruption extends both to vowels and consonants. There are also corruptions of sense, although not so frequent.

Of the 140 Malayan words, 42 are exclusively Malay, 15 exclusively Javanese, and 73 common to these two languages, while two are, I think, Bugis. The number is completed by eight, suspected to be Sanscrit, of which six are tolerably certain. These Sanscrit words are popular in the languages of the Indian archipelago, and have every appearance of having been received into the Malagasi through this channel.

All this will, I hope, be considered a sufficient refutation of the hypothesis, that the language of Madagascar is of the same stock with the Malay.

Passing over the languages of Sumatra, Java, Madura, Bali, and Borneo, which, in phonetic character and grammatical structure, bear much analogy to the Malay and Javanese, I shall take for my next example, the most cultivated, and widely-spoken of the languages of Celebes, that of the Bugis, called by themselves Wugi. This is a written tongue, with a peculiar native character, and differs essentially from the Malay and Javanese.

I am enabled to render some satisfactory account of the Wugi, from possessing a vocabulary of it in the native character.* The vowels of the Wugi are seven in number, *a*, *e*, *i*, *o*, *u*, *ö*, *ü*. According to the author of the vocabulary, the *ö* has the same sound as this letter in the German word Köningberg, and the *ü* is the *u* of the French. The *á*, equivalent to our commonest sound of *u*, so frequent in the Malay and Javanese, is wanting. The diphthongs are the same as in Malay and Javanese, viz., *ai* and *au*.

The Wugi consonants are 15 in number, instead of 19, as in Malay and Javanese. They are as follows: *b*, *c̃*, *d*, *g*, *j*, *k*, *l*, *m*, *n*, *ṅ*, *p*, *r*, *s*, *t*, *w*. It wants the palatal *d̈* and *'t* of the Malay and Javanese, with *ñ* and *y*. The nasal *ṅ* has no representative as a consonant in the alphabet; it follows a vowel only, and is marked by a point over the preceding letter. The sharp aspirate *h* is ranked among the consonants, and may precede or follow a vowel. The letter *k*, at the end of a word, is used as a soft aspirate; and with this exception, that of the aspirate and the nasal *ṅ*, every Bugis word must end in a vowel or diphthong. Thus the Malay word *mawar*, a rose, becomes *mawara*, and *rampas*, to plunder, by a double elision, and the substitution of a diphthong for a vowel, *rapai*.

* A Vocabulary of the English, Bugis, and Malay Languages, containing about 2000 words. Singapore, 1833. (By the Rev. Mr Thomson.)

The grammar of the Wugi is extremely simple. Gender and number are expressed by native adjectives; and relation of nouns by prepositions, differing, however, wholly from those which act the same part in Malay and Javanese, which is the same thing as the saying of languages of complex structure that their declensions are wholly different.

The Wugi has native pronouns of the first, second, and third persons; which last, it may be noticed, are wanting in the Javanese. It has also pronouns expressing plurality.

Neuter verbs, adjectives, and participles, are formed from roots, which are usually nouns, by the prefix *ma*, evidently a different thing, in sense and sound, from the transitive prefix *má* of the Malay. The word *hosi* means "rain," and *mahosi*, "to rain." *Puti* is the noun "white," and *maputi*, the adjective "white," or the verb "to be white." Transitive verbs are formed by the affix *i*, according to one of several forms for such verbs in Malay, but not Javanese. Thus, *gönčini* is "a pair of scissors," and *gončini*, "to shear or clip."

An examination of 1777 words of the Wugi vocabulary gives the following results. The number of 1352 are native words; 109 are Malay; 16 are Javanese; and 300 are common to these two languages. The proportion of Malayan words to native, therefore, is less than 24 to 76 in 100, or less than a fourth part of the whole.

I may add, that in 1810 words, there are in the Wugi 33 words of Sanscrit, being the same that are popular in the Malay and Javanese, and not improbably introduced through them.

From this account it will be seen, that the Malayan words in the Bugis language form something like a similar proportion to the native portion of it that the French does to the Anglo-Saxon in our own language; and it may safely be added, that it is not more essential to its structure.

The great alterations generally effected in the form of Malayan words introduced into the Wugi, seem to me plainly to attest their foreign origin. We find in them, changes by permutation, both of vowels and consonants, changes by addition of vowels, and changes by elision of consonants. I shall only give two or three examples. *Kayu*, wood, is in Wugi converted into *aju*, by the loss of the first consonant, and the conversion of the second, which does not belong to the Wugi, into *j*. *Lutut*, the knee, and *kulit*, skin or rind, become, in Wugi, *utu*, and *uli*, by the loss both of their initial and final consonants. *Cármin*, a mirror, becomes *c̃ami*, by the change of *á* for *a*, the elision of the *r*, which would not be followed by another consonant without the intervention of a vowel, and the elision of the final consonant, which is one that could not end a word.

The same inference of a foreign origin is, I think, to be deduced from the nature of the Malay and Javanese words found in Wugi. Among these there are 240 nouns, 35 adjectives, and 85 verbs. Among the 52 pronouns of the Bugis, I can discover but three that can be suspected Malay or Javanese. In 69 adverbs, I find three only that are of these languages; and out of 16 conjunctions, and 26 prepositions, there is but one of each that belongs to them.

The languages of the Philippine islands form a peculiar group, differing very essentially from the Malay and Javanese languages. Several of those of the great island of Luçon have received a large amount of culture, and, like the principal languages of the western portion of the archipelago, are written tongues, with a peculiar and distinct alphabet.

This alphabet, the same for all the languages, has five vowels—*a*, *e*, *i*, *o*, *u*; and 4 diphthongs—*ai*, *ao*, *au*, and *ui*; with sixteen consonants, besides the aspirate, viz., *b*, *d*, *g*, *j*, *k*, *l*, *m*, *n*, *ñ*, *ṅ*, *p*, *r*, *t*, *w*, *y*. Of the vowels, therefore, it wants the *á* of the Malay and Javanese, while it possesses two diphthongs, which these have not. Among the consonants, it has all those of the Malayan languages except the sound *c̃*, and the palatal *ḋ* and *ṫ*.

Words or syllables, in the Philippine languages, may begin with the aspirate, but not end with it, which is exactly the reverse of what obtains in the Malay and Javanese.

In the Philippine languages words may end, and very generally do, in consonants, as obtains in the Malay and Javanese, but contrary to the usual practice of the languages of the neighbouring island of Celebes. No consonant coalesces with another in the Philippine languages, with the exception of the liquids *r* and *l*, and these not often.

In the Philippine languages, certain consonants follow others without the intervention of a vowel, which in Malay and Javanese are never found to do so. The letter *g*, which very rarely ends a Malay or Javanese word, is a very frequent termination of Philippine ones. Of these two peculiarities the following are examples from the Bisaya language:—*Lobtog*, a jar; *yagbak*, a rat; *toltog*, to pound; *tag*, lord or master; *tuig*, time; which are sounds utterly repugnant to Malay or Javanese pronunciation.

Between the grammatical structures of the Malay and Javanese and the Philippine languages, there is a very wide difference. In order to illustrate the extent of it, I take the grammar of the Pampanga, one of the six principal languages of Luçon, for an example.*

The noun is simple, or without any inflexion. As the author of the grammar says, it undergoes no more change than the Latin word *genu*. Relation, or case, is expressed by what the Spanish author of the grammar calls an article. This varies, or, more correctly, is a different word for each case. There is, besides, one kind of article for appellatives, and another for proper names.

If the words thus called articles by the Spaniards be, as is probable, only prepositions, then it must be observed that they bear no resemblance to any prepositions of the Malay or Javanese.

A still wider difference exists in the pronouns. The personal pronoun of the first person has two genitive cases, and three plurals: a dual, "we two;" a plural general, "we all;" and a plural particular, "we in particular."

The pronouns of the second and third persons have but one plural. The demonstrative and interrogative pronouns have also one plural only.

Adjectives are formed from roots, as in the Wugi of Celebes, by the prefix *ma*.

The verb, according to the Spanish author of the gram-

* Arte de la lengua Pampanga por Diego Bergaño. Quarto. Manila, 1736.

mar, is of considerable complexity, and has several conjugations. Its moods and passive forms are composed by auxiliaries, but its tenses by inseparable prefixes. One portion only of the Pampanga verb resembles the Malay and Javanese, or, at least, one form of these. This is the verbal noun, which is formed by the affix *an*, added to the root.

In order to find the proportion of Malayan words in the Philippine languages, I have carefully gone over two dictionaries of the most prevalent of them, the Tagala and Bisaya of Luçon,* the last of which has spread to Magindanau and the Sulu group.

The Tagala Dictionary contains above 12,000 words, but excluding compounds about 7700. Of these 77 are Malay, 20 are Javanese, and 156 are common to these two languages. This makes the whole number of Malayan words 253, which gives the proportion of about 33 in 1000. The Tagala Dictionary contains also 24 words of Sanscrit, which, I have no doubt, found their way into the language through the Malayan tongue.

The Bisaya Dictionary contains 9000 words, of which 72 are Malay, 17 Javanese, and 197 are common to those languages, making, in all, 286 Malayan words, or about 30 in 1000—a proportion not very different from that of the Tagala. The Bisaya contains also Sanscrit words, but I can find only 13.

The Malayan and Javanese words introduced into the two Philippine languages have often undergone great corruptions, both in sound and sense. Thus, the word *báli*, "to buy," in Malay, is written *bili* in Tagala, and is interpreted "price," or "cost." *Buna*, in Malay, is "a flower" or "blossom," and in Tagala it is "fruit." *Pintu*, in Malay and Javanese, is a "door" or "gate;" but in Tagala, written *pinto*, it means "a house." *Lubah*, in Malay, is a "hole," "aperture, or "pit;" and in Tagala, written *lubun*, it signifies "interment," and "a grave." *Utan*, in Malay, means "a forest" or "wild;" but in Tagala, "foliage" and "verdure."

* Vocabulario de la lengua Tagala compuesta por N. H. Fray Domingo de los Santos. Fol. Tagalcas, 1703. Vocabulario de la lengua Bisaya por el R. L. Matheo Sanches. Fol. Manila, 1711.

Sometimes one of the Philippine languages gives the sense more correctly than the other. Thus, the Malay word *bau*, "odour" or "smell," is, in Tagala, "stench" or "bad smell," while in Bisaya the Malay sense is correctly given. In Malay and Javanese, the word *tali* signifies "a rope," "string," or "cord," but in Bisaya it is "a sash;" while in Tagala it is correctly rendered. *Naṅa*, "to gape," in Malay, is, in Tagala, "to open," "to masticate," "to eat;" while in Bisays it signifies "to open the mouth," making a nearer approach to the true meaning.

The Sanscrit words introduced into the Philippine language have been equally corrupted with the Malayan. Thus, the word *c̃inta*, "affection," is correctly written in Malay and Javanese, but in the Tagala and Bisaya the letter *c̃* not existing, *s* is always substituted for it, and *c̃inta* becomes *sinta*.

The well-known Sanscrit word *Avatar*, meaning "descent," and commonly applied to a descent or an incarnation of Vishnu, is corrupted in the Malayan languages into *Batara*, and not confined to the incarnations of Vishnu, but applied as a generic term to any of the chief Hindoo gods. This is the sense in which it was used by the Philippine islanders on the arrival of the Spaniards, but by a permutation that is frequent with words introduced from the Malayan, *l* is substituted for *r*, and an aspirate being added, the word has become *Bathala*.

The Spanish missionaries found this word ready to their hand, and applied it as an appellative to the Deity; so that, by a strange coincidence among the native Christians of the Philippines, the Hindoo *Avatar* comes to be the translation of the Jehovah of the Jews, and the Dio of the Spaniards.*

The nature of the Malay and Javanese words introduced into the languages of the Philippines, points, I think, plainly enough to their foreign origin. Of these found in the Ta-

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* Baron William Humboldt, in his great work the Kawé Sprache, seems to consider the Philippine languages as exhibiting the supposed great Polynesian language in its greatest purity, but on what ground I am not aware. As far as my judgment goes, the common terms are greatly-corrupted Malay and Javanese.

gala, nearly one-half are substantive nouns, or names of things. The pronouns amount only to two, the adjectives only to five, and there is but a solitary preposition. In a great majority of cases the Malay and Javanese words are only synonymes, and the language could not only be written with ease without them, but suffer little by their omission.

I come next to the languages of the Pacific. A language, essentially the same, is spoken in the Sandwich, the Society, the Marquesas, and the Friendly Islands, the Lowe Islands, Easter Island, and New Zealand—that is, from the Tropic of Cancer to the 46° of south latitude. This is one of the most extraordinary phenomena in the history of language; and there is certainly nothing parallel to it, either within the Pacific itself, or the islands of the Indian Archipelago.

To illustrate this language, I shall take the Tahitian and New Zealand dialects for examples, good grammars and dictionaries of both having been published.* The French have called this widespread language the Ouanic, and other European nations the Polynesian, which last, as most general, I shall adopt.

The vowels of the Polynesian, as exemplified in the New Zealand, are five in number—*a*, *e*, *i*, *o*, *u*; the diphthongs—six *ae*, *ai*, *ao*, *au*, *ei*, and *ou*; and the consonants only eight—*k*, *m*, *n*, *h*, *p*, *r*, *t*, *w*, exclusive of the aspirate. Thus it has one vowel less than the Malay and Javanese, and three times as many diphthongs, while it wants no fewer than eleven consonants of the Malayan series.

The aspirate is largely used, and in a manner contrary to the usage of the Malay and Javanese, for it must always precede, but never follow, a vowel—consequently never end a word or syllable.

Every syllable and every word must end in a vowel, and when foreign words are introduced ending in a consonant, the consonant is either elided, or a vowel added. No conso-

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* A Grammar of the Tahitian Dialect of the Polynesian Language. Tahiti, 1823. A Dictionary of the New Zealand Language, and a Concise Grammar, by William Williams, Archdeacon of Waiapu. Pahia, 1844. Vocabulaire Oceanien-Français et Français-Oceanien. Par L'Abbé Boniface Mosblech. Paris, 1843.

nant ever coalesces with another; or, in other terms, a vowel or diphthong is always interposed between two consonants.

The paucity of consonants, and the frequency of vowels and diphthongs, necessarily convey to a stranger a sense of monotony and feebleness. Thus, the word "to shiver with cold," *kauaehañuru*, notwithstanding its length, contains but two consonants. *Tiahuahu*, "to distribute" or "scatter about," and *puhihihi*, words each of eight letters, have but a single consonant a-piece. These are sounds so utterly repugnant to the genius of Malayan pronunciation, that a Malay or Javanese could hardly articulate them.

The grammar of the Polynesian language is nearly as widely apart from that of the Malay or Javanese as its phonetic character. The Polynesian has two articles, parts of speech unknown to the Malay and Javanese, but bearing some analogy to those of our own language. The cases of nouns are expressed, not by inflexions, but prepositions, which, however, differ wholly from those which serve the same purpose in the Malay and Javanese languages.

The noun has a plural formed by the inseparable prefix *ña*. Gender is designated by adjectives; but these differ not only from those of the Malay and Javanese, but from those of every other language of the Archipelago that I have examined.

One of the most remarkable differences between the Malay and Javanese languages on the one hand, and the Polynesian on the other, consists in the latter having a singular, a dual, and a plural number to its pronouns of the second and third persons. The only languages of the Archipelago that have something resembling this peculiarity, are those of the Philippines; but here it is the pronoun of the first, and not of the second and third persons that have numbers.

The Polynesian verb differs entirely from the Malay and Javanese. The simplest form of it is the neuter or active verb, which may be considered the root. This is made causal by the prefix *waka*, and passive by the affix *a*. The moods are formed by particles; and the tenses, of which there are six, by the help of prefixes, affixes, or adverbs. A verbal noun is formed by adding to the root the inseparable particle *ña*, under certain rules of euphony.

The New Zealand Dictionary contains about 6000 words; but omitting derivatives, about 5500. I have carefully gone over it, and can discover in it only 107 words belonging to the Malayan languages. Of these 24 are Malay, 16 Javanese, 59 common to these two languages, and 8 belonging to the Bugis or Wugi of Celebes. The proportion, then, of Malayan words in the Polynesian, to judge by the dialect of New Zealand, is less than 20 in 1000.

There are two words in the New Zealand which may possibly be Sanscrit. *Apiti*, "to join," may be the word *apit* of the Malay and Javanese, taken from the Sanscrit, and meaning "close, pressed together;" and *tapu*, the well-known *tabu*, may be the *tapa*, or religious penance of the Hindoos, found in almost every language of the Indian Archipelago. The addition of the vowel, in the case of *apit*, has already been explained; and of the permutation of the final *a* into other vowels, we have several examples, as *kapu*, "an axe," for *kapak; tanu*, "to bury," for *tanam; ono*, "six," for *anam;* and *rami*, "to squeeze," for *ramás.*

From the wide discrepancy which exists between the phonetic system of the Polynesian and Malayan languages, the words of the latter introduced into the former, are of course, greatly corrupted in form. The Malay and Javanese word *api*, "fire," becomes, for example, *ahi; Buah*, "fruit," becomes *hua; minum*, "to drink," *inu; salah*, "a crime," *hara; papan*, "a boar," *papa; tahun*, "a year," *tau;* and *daun*, "a loaf," *rau.*

Corruptions in sense are also frequent. *Mata*, "the eye," in Malay and Javanese, means "the face" in the New Zealand. In the Marquesas, however, this word has the correct meaning of "the eye," as well as the improper one of "the face." Although this word, however, in its literal sense is misapplied, it is remarkable that, in some of its figurative meanings, it is correctly used, as for the "mesh of a net," "the point" or "blade" of a weapon, and "a spring" or "fountain." *Batu* or *watu* is a stone in Malay and Javanese, but in the New Zealand it means "hail" and the "pupil of the eye," figurative senses of it in the two first languages. *Rahi*, in Javanese, means "the face," but its literal meaning in the New Zealand is "forehead," and its figurative "a promontory."

The Malayan words which have found their way into the Polynesian, are far too few and unimportant to form an essential portion of the language, the grammatical structure of which is complete without reference to them. In point of number, in fact, they do not exceed that of the English introduced, within the last thirty years by the English and American missionaries, into the dialects of the Marquesas and Sandwich Islands.* These last, too, it may be added, have undergone the same inevitable mutilations. Thus, to give a few examples, a book has become *puke;* paper, *pope;* school, *kula;* bread, *palena;* powder, *paora;* a shoe, *hiu;* the cow, *pifa* (beef); the sheep, *hipa;* riches, *mamona* (mammon); and a church (*ecclesia*), *helipulue.*

Although the dialects of New Zealand, Tahiti, the Marquesas, Friendly, and Sandwich Islands, are admitted by competent judges to be the same language essentially, there still exist between them some material discrepancies, both as to sound and words.

Thus, in the Tahiti, there are nine consonants, instead of eight, as in the New Zealand. It has *b*, *d*, *f*, and *v*, which the last wants; while it wants *k*, *n*, and *w*, which the New Zealand has. The Marquesa has but seven consonants, viz. *k*, *m*, *n*, *p*, *t*, and *v;* and the Sandwich Island is the poorest of all, for it has but six, viz. *k*, *l*, *m*, *n*, *p*, and *v*.

The proportion of Malayan words in the Marquesa and Sandwich Island dialects is smaller than in the New Zealand. Most of those words are the same, although often much altered in form; but I find at least twenty words of Malayan in the New Zealand not existing in the other two dialects. The pronunciation is also most correctly given in the New Zealand, and least so in the Sandwich Island.

The language of the Feejee islanders was, for some time, considered to be different from the great Polynesian, but is now well known to be only a dialect of it. I have seen no vocabulary of it of sufficient length to enable me to form any

* "Vocabulaire Océanien-Français et Français-Océanien par L'Abbe Boniface Mosblech. Paris, 1833." This work appears to be drawn from good materials, and is exceedingly well executed.

judgment of it. Its alphabet, however, has been correctly given, and this consists of the usual five vowels, and not of six or nine consonants like the Polynesian, but of fifteen, viz., *b*, *d*, *f*, *g*, *j*, *k*, *l*, *m*, *n*, *ṅ*, *p*, *r*, *s*, *t*, and *v*, which, for variety of intonation, puts it on an equality with the Wugi of Celebes, although it leaves it, by four letters, short of the Malay and Javanese.* The Feejee language contains Malayan words, like the other languages of Polynesia; but in what proportion I am not aware.

Our materials for forming a judgment of the languages of the Negro races are, as might be expected, from the rudeness or the ferocity, or remoteness of these tribes, extremely imperfect. One of the longest list of words of any of their languages which I have seen, is one furnished to myself, in 1811, by the then minister of the Raja of Queda. It is of the language Sámang of the Járai, one of the highest of the mountains of the Malay Peninsula. It consists of 176 words, to which I add twenty-one of the language of the same people, from the work of Mr Marsden.†

The phonetic system of the language of the Sámang is not very remote from that of the Malay and Javanese; but it seems to abound more in aspirates, gutturals, and monosyllables. Syllables and words may end with vowels or consonants, but do so most frequently with the latter.

In the 191 words to which I have alluded, I find that 156 are native, that fifteen are Malay, two Javanese; that twenty-three are common to these two languages, and that one word only is Sanscrit. The proportion of Malay and Javanese words, therefore, is nearly eighteen in 1000.

As in the case of the languages of the brown-complexioned races, the existence of the Malay and Javanese words may be considered as in a great measure fortuitous; and neither in character or number can they be considered as forming any necessary part of the Sámang language.

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* Introduction to a Grammar of the Tahitian Dialect of the Polynesian Language. Tahiti, 1833. An Australian Grammar, &c. &c., by L. L. Threlkeld. Sydney, 1834. Narrative of the United States' Exploring Expedition, 1847.

† "On the Polynesian and East Insular Languages." Miscellaneous Works. 1834.

I have compared, with this specimen of the language of the Sámang, the few words given by Colonel Colebroche, in the Asiatic Researches, of the language of the Andaman Islands, and the result is that no two words are alike, and that the latter contains no word of Malayan origin.

De Dentrecasteaux* has given a list of 103 words of the Negro language of Wageou, lying off the north-west end of New Guinea, as already alluded to. To judge by the appearance of this list, it seems to embrace all the sounds found in the Malay and Javanese, but it contains, besides, two letters, *f* and *z*, which are unknown to these. The 103 words contain eighteen which are also found in Malay and Javanese. Of these ten are numerals, greatly corrupted; two are synonymes, occurring with native terms; one is Tálagu, and one Portuguese, both, no doubt, derived from the Malay.

On comparing the native portion of the language of Wageou with that of the Sámang, and the few words of the Andaman, no resemblance can be found between them.

De Dontrecasteaux gives another list of the language of a Negro people who visited the French ships while they lay at Boni harbour in Wageou, and whom he describes as having flat noses, very thick lips, and short woolly hair. Every word of this language, which he supposes to be of New Guinea, differs from that of Wageou; nor does a single word of Malay or Javanese occur in it.

M. Duperry has given the ten digits of three Negro languages, two of New Guinea, and one that of New Ireland. In the first in order of those of New Guinea, the numbers 5, 6, and 10, are Malayan, greatly corrupted. The second, said to be that of the inhabitants of the interior, does not contain even one word that is Malayan. But in the language of New Ireland we find the numbers 3, 4, 5, 6, 8, 9, and 10, all Malayan.

Forster† has thirty-three words of the language of Malicolo, one of the New Hebrides, the population of which group appears to be Negro. Cook observes, that the people of Ma-

* Voyage autour du Monde. Paris, 1808.

† Forster's Observations on Cook's Voyage. 1776.

licolo "seemed to be quite a different nation from any we had yet met with, and speak a different language. Of about eighty words collected by Mr Forster, hardly one bears any affinity to the language spoken at any of the islands I had ever been at. I observed that they would pronounce most of our words with great ease. They express their admiration by hissing like a goose."*

The words given by Forster accord with this description of its phonetic character. They imply 12 consonants, instead of the meagre numbers of the Polynesian dialects. These are *b, d, g, k, l, m, n, ṅ, r, s, t,* and *y*; and they are combined in a manner not only unknown to the Polynesian, but to the Malay and Javanese, as *db, ts,* and *rg*.

Among the thirty-three words, there are three which are corrupted Malayan: the words "eye," "ear," and the verb "to die," which, however, instead of *mati*, is *mats*.

Another Negro language is that of Tanna, also one of the New Hebrides. Forster gives forty-one words of it. Cook observes of it: "It is different from any we had before met with, and bears no affinity to that of Malicolo; so that it would seem the people of this island are a distinct nation." †

To judge by the list of words, the Tanna has thirteen consonants, several of which differ from those of the Malicolo. They are *b, f, g, k, l, m, n, ṅ, p, r, s, t,* and *v*. The words abound more in vowels than the Malicolo, and the harsh combinations of them existing in the latter are absent.

There are but two words in the Tanna which are the same as in the Malicolo, those for the verb "to drink," and for "a house." There are six Malayan words, viz. that for "a cocoa-nut," for "land or country," for "the sea," for "fish," and for "a chisel," which last is erroneously translated by Forster, "hatchet." I can find in it only one word of the Polynesian, that for "chief," or "priest."

Of the language of New Caledonia, Forster has given thirty-eight words. This seems to have twelve consonants, differing in some respects both from those of Tanna and Malicolo. They are *b, g, k, l, m, n, ṅ, ñ, p, r, t,* and *w*. Cook considers this lan-

* Cook's Second Voyage. † Ibid.

guage as a mixture between that of Tanna and the Polynesian. I do not find one word in it in common with the Tanna, except such as both have borrowed from other languages. Those common to it with the Polynesian are the verb "to eat," the word for "moon," and the words for "chief," or "priest," which last it has in common with the Tanna.

The Malay words contained in the New Caledonia are five in number,—that for "a cocoa-nut," for "the ear," for "fish," for "water," and for "a yam,"—all in a corrupt form, as *nu* for *ñur*, a cocoa-nut; *galina* for *taliña*, the ear; and *ufi* or *ubi*, a yam.

Not one of the three Negro languages just mentioned contains a word that is common to the Negro languages before enumerated, except such as all have derived from a third source, the Malayan.

To this meagre list of the Negrito languages, I have to add the more copious ones furnished by Mr Jukes, of the languages of the Torres Straits islanders. The vocabularies which he furnishes are six in number, and amount to from 37 words up to 545. The vowel sounds appear to be *a*, *á*, *e*, *i*, *o*, *u*, and the diphthongs *ai* and *au*, which agrees exactly with those of the Malay and Javanese. The consonants seem to be *b*, *c̃*, *d*, *g*, *k*, *l*, *m*, *n*, *p*, *r*, *s*, *t*, *v*, *w*, and *z*, together with a sound represented by Mr Jukes as *dh*, *dz*, and *j*. If there be such sounds, it is clear that there are really three distinct consonants, and that if these people had invented an alphabet, each would have its distinct character. If this be the case, there are 18 consonants, besides the aspirate, which these languages have.

In all these languages, I find but one word which is Malay, and even this is confined to a single language, that of Masseid or York Island. This is *mareck*, which the natives applied to the domestic fowl which they saw in the hen-coops of the Fly, for they have none of their own. The word is, no doubt, a corruption of the wide-spread Malayan *manuk*, and probably borrowed from New Guinea, which the natives of the islands of Torres Straits appear sometimes to visit. There are two other words which are very doubtful. In two of the languages, the cocoa-nut is called *boonarri*, which may be a corruption of the Malay words *buah ñur*, or the fruit of the cocoa-nut; and in a third the same object is called *woo*, which may be a corruption of the Malay *buah*, or the Javanese *woh*, "fruit" or "the fruit."

Comparing the languages of the islands in Torres Straits with those of Malicolo, Tanna, and New Caledonia, there are certainly no two words in common between them. Even the numerals are wholly different; and while the Polynesian negroes count as far as 10, Torres Straits islanders can proceed no further than 6, and even this only by combining one and two.

From the details which have now been given, it will be seen that Malay and Javanese words, as I stated before, have found their way into the languages of the Archipelago and Pacific, or other neighbourhood, in proportion to facility or difficulty of communication with the parent countries of these two languages, Sumatra and Java. The facilities and difficulties have consisted of proximity or distance, geographical and navigable; of similarity or dissimilarity of race, of similarity or dissimilarity of lingual idiom, and attraction or repulsion from disparity in the condition of civilization.

The influx of Malay and Javanese words will be found large in the proportion of the facilities; and small as they diminish, until, by an accumulation of difficulties, they cease altogether.

Malay and Javanese words have not been traced to the languages of the continents of Africa and America. Madagascar seems to intercept them from the first; and the want of stepping-stones or stages between Easter Island and the west coast of America, with adverse winds and currents, from the last.

Wherever they have been received, the Malays and Javanese will be found in a higher state of civilization than the nations into whose languages theirs have been adopted. Wherever, on the contrary, the nations with whom they have held intercourse have been in a higher state of civilization than themselves, their languages have been rejected, and the languages of those nations even adopted into their own.

The Hindoos, in a higher state of civilization than the Malays and Javanese, have wholly rejected their languages; but, on the contrary, in the course of an intercourse of many ages, have borrowed largely,—of which, if this were the proper time, I would, through the friendship of a learned and ingenious orientalist, who is an ornament of this University, furnish larger and more satisfactory evidence than has ever been adduced before.

The same cause has excluded the Malay and Javanese from the languages of Arabia and Persia, notwithstanding an intercourse of at least five centuries; while those languages have been to a considerable extent largely adopted both by the Malays and Javanese.

Superior civilization, and probably not less, the uncongenial monosyllablic character of their languages, has excluded the Malayan languages from the regions east of Hindustan. The Siamese, although in immediate juxtaposition with the Malay, has neither given the latter words, nor, with the exception of about half a dozen, received any thing from it.

This remark is still more applicable to the Chinese languages, which have not only borrowed nothing from the Malayan languages, but conferred little or nothing on them, notwithstanding the intercourse and settlement of centuries.

It is a striking fact, that not a word of any Malayan language is to be found in any of the many languages of Australia. I should have expected them, for example, in the language of Raffle's Bay, which is close to the stations frequented, probably for many ages, by the Tripang fishers of Macassar; but there is not a word to be found in it. This is not to be accounted for by difference of race or difference of idiom, for the languages of the Negro races of the Archipelago contain Malayan words; and so does that of the far more distant Easter Island, of which, in so far as pronunciation is concerned, the genius is more remote from the Malayan than is that of the Australian.

The absence from the Australian languages of all trace of the Malayan, can, I think, only be accounted for by the very low social condition of the Australian race, which seems, as if it were, to have repelled all knowledge derived from a superior one.

In order to shew the proportion in which Malayan words are found in the various languages which have received them, I give a few examples. In the Madura, one of the two languages of the island of that name, in 1000 words, it is 581; in Sunda, one of the two languages of Java, it is 528; in Lampung, one of the six languages of Sumatra, it is 516; in the Wugi, one of the many languages of Celebes, it drops down to 233; in the Tagala of the Philippines, it is but 33; in the New Zealand, it is but 20; and in the Malagasi, but 17.

A few instances occur of the languages of tribes so situated that we might fairly expect them to contain a considerable portion of Malay and Javanese, but which really contain very little. The most remarkable example of this is the Tambora of Sumbawa. This island is only the third from Java, and nearly in the centre of the Archipelago, while the people who speak the language are of the brown-complexioned lank-haired race, like those who speak two other languages of the same island, both containing a large influx of Malay and Javanese, yet, out of forty-eight words, the Tambora contains but two words, *bulu*, "a hair," and *makan*, "to eat."*

Another example, although not so striking a one, is afforded by the language of the Pelew or Pilu Islands, inhabited by a brown-complexioned and lank-haired race, and not more than eight degrees east of the Philippine group. In 658 words of it, I can discover only three which are Malayan. Yet a considerable number of Malayan words are found in the language of the Bashee Islands, and in that of the native inhabitants of Formosa; and a still larger in the Sandwich Island dialect of the Polynesian, ten times as far from the Philippine as the Pelew group.†

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* It was in the country of the people of Tambora that took place the greatest volcanic eruption on record, that of 1814; and the nation is said to have been nearly destroyed by it.

† Account of the Pelew Islands from the Journals of Captain Henry Wilson, by George Keate, Esq. London, 1788.

An argument in favour of one original tongue has been attempted to be deduced from the supposition that the Malayan words, so widely dispersed, express, in most cases, the simplest and earliest ideas of mankind. My friend, the late Mr Marsden, with his usual good faith, has given a list of 34 such words in 72 languages, on which, with other words of the same imagined class, I shall offer a few observations.*

Among the words imagined to express a simple and primitive class of ideas, the numerals have been much insisted on. It is obvious enough, however, that the numerals, especially a decimal series of them, extending like the Malayan, to 1000, are far from being words expressing such a class of ideas. On the contrary, they must be the invention of a comparatively advanced period of civilization. Thus, among the many languages of Australia, the inhabitants of which are far below the humblest of those of the Indian and Pacific islands, there is not one that has numerals going beyond " four," and even the last number is attained only by doubling the number two.

But there are some languages of the Archipelago and Pacific Islands, and this of the brown-complexioned race, which have preserved their own native numerals entire. This is the case with the language of Tambora in Sumbawa, with the Ternati, and the Tidovi, two of the languages of the Moluccas, and with the language of the Pelew Islands.

In some languages, again, the native numerals have been preserved as far as " three" or " four," and the series completed with the Malayan, as in the Gorongtalu of Celebes, and the Mangarai of Flores.

The same is the case in the languages of the Negroes as in those of the brown-complexioned men. Some have adopted and some rejected the Malayan system. The negroes of Wageou, and of the coast of New Guinea, with the natives of New Ireland within the Pacific, have, to a greater or less extent, adopted the Malayan numerals, while the Sámang of the Malay Peninsula, the Alfours of the interior of New

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* " On the Polynesian or East Insular Languages." Miscellaneous Works. 1834.

Guinea, the people of Malicolo, of Tanna, and of New Caledonia, have each their own native system, unaffected by the Malayan.

Some languages have numerals as far as "five," and clumsily continue the series of the digits from their native resources, by adding "one," "two," &c., to the last named number, so that six is expressed by "five" and "one," and "seven" by "five" and "two." This is the case with the New Caledonia.

Others seem to have relics of a binal scale, and combine it with the Malayan decimal one, as in the Endé of Flores. In this, for "one," "two," "three," and "five," the Malayan terms have been adopted, but instead of being continued beyond this, "six" and "seven" are expressed by the Malayan words "five and one" and "five and two." Four is expressed by a native word, and the Malay numeral "two" prefixed to it expresses "eight," that is, two fours.

The native Malayan system extends only to 1000, and even to this extent it is not carried by all the tribes that have adopted it. It is doubtful whether the terms for *ten* and for *hundred*, in the different dialects of the Polynesian, and which differ among themselves, are Malayan; the word for thousand, *mano*, certainly is not. In the Lampung of Sumatra, a written language, the term for this last number is the same which means an "iron nail or spike."

For the numbers above 1000, the Malayan system has borrowed from the Sanscrit; and the Javanese, but it alone, goes as far with the higher numerals as "ten billions." There are two remarkable misapplications of the Sanscrit numbers: the Laksa and Kati, the well-known *lac* and *krove* which ought to express a hundred thousand and ten millions, express, through all the cultivated languages of the Archipelago, "ten thousand" and "a hundred thousand" only.

From the explanation now given, I think it must be sufficiently obvious that the Malayan numerals afford no evidence whatever of the existence of one great original language. They seem simply, and as opportunity offered, to have been adopted as a matter of convenience—in some cases in their entireness, but for the most part only partially.

Among the Malayan words most generally diffused, and considered to be of the class representing the most simple and primitive ideas, are the terms for " man," " bird," " fish," &c.; but these are obviously general or abstract terms, and necessarily could not have been among the first invented. The Australians, according to Mr Eyre, have no such terms.* It may be conjectured, indeed, that the want of such terms in the ruder languages both of the Archipelago and Pacific, is one cause of the frequent occurrence of such words from the Malayan as *kayn*, " tree" or " timber;" *buah*, " fruit;" *buṅah*, " flower;" and *manuk*, " a bird."

The very first word of Mr Marsden's list, " man," occurs in its Malay form of *oráṅ* only in two other languages of the Archipelago, the Madura and Achin, and these are known to have received more Malay than any others; while in the many languages of the Pacific it does not occur at all. On the other hand, two Sanscrit words having the same meaning represent the same idea in no less than ten languages of Mr Marsden's own list.

The members and other parts of an animal body, natural objects, such as water, fire, earth, a stone, sun, moon, stars, do really represent the earliest and simplest ideas, but their wide dissemination is easily enough accounted for. In fact, they are, for the most part, only synonymes along with native terms, or, at best, words that have, in the lapse of time, displaced the latter, as they have themselves been frequently displaced by Sanscrit words.

To give a few examples: in the Malagasi, besides the Malayan word, there is one native one for " the sky," there are two for " the tongue," two for " a stone," four for " fire," five for " the eye," five for " the head," and seven for the verb " to die."

In the Bisaya of the Philippines, there are, besides the Malayan words, two native ones for " a stone," two for " earth," four for " shore" or " beach," and six for " air" or " wind."

In the dictionaries of these last languages, I observe that

* Discoveries in Central Australia, by John Edward Eyre. London, 1845.

the Malayan word is generally placed first in order, whence I infer that it is probably the most current and acceptable ; and this, I have no doubt, it owes to its more agreeable and facile pronunciation. Thus, in the Malagasi, it is not difficult to understand how *vatu*, for a stone, should be preferred, even by a native, to *hodiboamkazo*.

That agreeableness of sound and facility of pronunciation have had a considerable share in the spread of Malayan words, I think highly probable. Thus, the Malay word *laki*, a man or male human being, is one of very easy pronunciation, and has extended to nearly every language of the Archipelago, while its correlative, *párámpuan*, woman, a primitive of four syllables, and not very euphonious—rare in any of the Malayan languages—is found in one other language only, that of the Bima of Sumbawa, which abounds in Malay words.

Of Sanscrit words expressing simple ideas, that have either superseded, or are more popular than native ones, the examples are numerous ; as in Malay, *kapala*, the head ; in Javanese, *sira*, for the head ; *muka*, the face, *bahu*, the shoulder, and *anguta*, a member, in several languages ; *dina*, a day, in Javanese and Bali ; *hasta*, the arm, in several languages ; *dasa*, for the numeral *ten*, and *surya*, for the sun, in Bali. The elephant is unquestionably a native of Sumatra and the Malay Peninsula, but the popular name for it in at least eight languages of these countries is the Sanscrit word *gaja*. There is, indeed, another, *biram*, in Malay, but it is obsolete, or little known.

Instead of the elementary words of language being those most widely spread, the reverse is the case. Such words are the rarest to be found in many languages, and some of the most essential have not been disseminated at all, but are found to be distinct in each separate language. In fact, the class of words most widely diffused, are in a great measure extrinsic, and the offspring of a considerable advancement in civilization ; such, for example, as the names of cultivated, useful, or familiar plants ; those of domesticated, useful, or familiar animals ; terms connected with numeration, fishing, navigation, agriculture, the mechanical arts, the calendar, war, government, and even literature.

If, then, one language only had ever existed, we are reduced to the necessity of supposing that the people who spoke it were one race, and that they were in a social state of considerable advancement before they were dispersed, and their language broken down into the chaos of tongues at present existing, an hypothesis without the shadow of a proof.

Had such a language ever existed, we would not have failed to have had the same kind of evidence of it, which the modern languages of the south of Europe afford of the existence of Latin; that is, a virtual agreement in the most familiar nouns, adjectives, pronouns, verbs, prepositions, and particles; but of this there is nothing whatever in the languages of the Archipelago.

There are but two languages in the Indian and Pacific Islands that have been widely spread, the Malay in the first, and the Polynesian in the last; and the evidence of a common origin in these, respectively, is as satisfactory in their dialects, as that yielded by the French, Spanish, and Italian, of their common origin.

It remains to consider how the principal languages of Sumatra and Java, the Malay and Javanese, came to be so widely disseminated, as the theory which I adopt supposes them to have been, within the limited bounds of the Archipelago, to which I first confine my examination. I have no doubt the dissemination was effected, in the case of the languages of neighbouring tribes, by conquest, and in the more remote, by piratical expeditions, terminating in conquest and colonization; by commerce, and, perhaps, in some small degree, by religious agency.

The nearest parallels to this, with which the European reader is familiar, will be found in the piratical and commercial expeditions, conquests, and colonizations of the ancient Greeks, or the piratical expeditions, conquests, and settlements, of the Scandinavian nations, known as Danes or Normans.

Even without the knowledge of the compass, the monsoons afford, to the nations of the Indian Archipelago, extraordinary facilities for carrying on such expeditions and such commerce, far exceeding even those of the Mediterranean; and the voyages of the Malays and Javanese, consequently, far surpass in length, if not in difficulty, those of the early Greeks and Phœnicians.

When European nations first visited the Indian Archipelago, in the beginning of the sixteenth century, they found the Malays and Javanese conducting the first stage of that commerce in the clove and nutmeg, by which these valued articles found their way first into the markets of Continental India, and eventually into those of Arabia, Egypt, Greece, and Rome—that is, making trading voyages which extended from the western to the eastern bounds of the Archipelago. The spices in question were found in the Roman markets in the second century of our era; and the great probability, therefore, is, that the Javanese and Malay trade alluded to had, when Europeans first observed it, been going on for at least fourteen centuries.

The conquests and settlements of the Malays, the chief agents, have extended from the centre of Sumatra, the parent country of this people, over nearly all the coasts of that island itself, over the whole Malay Peninsula, and over nearly the whole coast of Borneo; while small settlements of them may be found as far as Timur, in one direction, and Luçon, the chief of the Philippines, in another.

The Malay language has, moreover, been, immemorially, the common medium of communication throughout all the islands. Magellan and his companions, in 1521, carried on an easy intercourse with the inhabitants of some of the small and remote islands of the Philippine group by means of a Malay slave of the Admiral; for although the native languages were different, the chiefs and persons engaged in commerce were all found to be acquainted with the Malay.

When again they arrived at Tidor, one of the Spice Islands, they found the Malay equally current, and the vocabulary in Pigafettas' Narrative, collected there, and consisting of 352 words, is, with the exception of 20 local terms, good and current Malay, such as is spoken at the present day. Yet Tidor and the other Moluccas have, to the present time, preserved their own peculiar languages wholly different from the Malay.*

The evidence for the agency of the Javanese, as its influence was less, is less palpable, but still sufficient. The Javanese had settled in various parts of Sumatra; and at Palembang in that island, their language still subsists entire, while through monuments, inscriptions, and names of places, it is to be traced in other parts of that island.

Similar evidence, although less complete, exists of their settlements in Borneo; and there is historical record of those made by them in the Moluccas, as well as of their predatory expeditions and commerce to the Malay Peninsula. The Javanese language, however, less euphonious than the Malay, more prolix and more difficult, was never employed as the common medium of communication; and it is not improbable that, even in their own especial settlements, it gave way to the Malay.

In its immediate neghbourhood, the influence of the Javanese has naturally been greater on the surrounding languages than that of the Malay. Thus, in the Sumánap, one of the two languages of Madura, there are, in 1000 words, 170 exclusively Javanese, and only 103 exclusively Malay. In the Bali, there are 127 Javanese, and 69 Malay: and in the Sunda of Java, 156 of Javanese, and only 44 of Malay.

As soon as we cross the narrow strait that divides Sumatra from Java, the proportions are reversed, although we find still a large amount of Javanese words. In 1000 words of Lampung we have 138 exclusively Malay, and 70 exclusively Javanese.

I should remark that the numerals, when they differ in Malay and Javanese, are, even in the remote languages, almost always those peculiar to the Javanese, and not to the Malay. These numerals are, 3, 7, 8, and 9; and the Malagasi, the Philippine tongues, and the Polynesian, with many intermediate languages, afford examples of this.

The different means of propagation now specified will I think, be sufficient to account for the facts, that such a lan-

* Prima Viaggio interno al globo terraqueo. Milano, 1800.

guage, for example, as that of the Lampungs, a people lying between and in the neighbourhood of the Malays and Javanese, should consist of nearly one half of the languages of these two nations; that the language of the remoter, Bugis of Celebes, should consist of only one-fourth of them, and that in the still more remote Tagala and Bisaya of the Philippines, the porportion should drop down to *one-thirtieth* part.

I have next to consider how the Malayan words existing in the language of Madagascar may have found their way into it. The inhabitants of Madagascar are Negroes, and in race differ wholly from the Malays and Javanese. The whole number of Malayan words in the Malagasi does not exceed *one fifty-seventh* part of the language, and they are, as I have shewn, not essential to it. There is, in short, nothing in common between the two races, and nothing in common between the character of their languages.

The Indian islanders are ignorant of the existence of Madagascar, and the people of Madagascar equally so of the existence of the Indian Islands. A navigation of 3000 miles of open sea lies between them, and a strong trade-wind prevails in the greater part of it. A voyage from the Indian Islands to Madagascar is possible, even in the rude state of Malayan navigation; but return would be wholly impossible. Commerce, conquests, or colonization are, consequently, utterly out of the question as means of conveying any portion of the Malayan language to Madagascar.

There remains, then, but one way in which this could have taken place—the fortuitous arrival on the shores of Madagascar of tempest-driven Malayan praus. The south-east monsoon, which is but a continuation of the south-east trade-wind, prevails from the 10° of south lat. to the equator, its greatest force being felt in the Java Sea, and its influence embracing the western half of the Island of Sumatra.* This wind blows from April to October, and an easterly gale during this period might drive a vessel off the shores of Sumatra or Java, so as to make it impossible to regain them. In such a situation she would have no resource but putting before

* See the Directory of my greatly-respected friend, the late Capt. Horsburgh.

the wind, and making for the first land that chance might direct her to; and that first land would be Madagascar. With a fair wind and a stiff breeze, which she would be sure of, she might reach that island without difficulty in a month.

Two or three such adventures are known to have taken place since our own occupation of the Mauritius, and, consequently, more frequent intercourse with Madagascar. Earl Grey, at my request, has most obligingly written to the Mauritius for the particulars of these strange adventures; and I am only sorry that the replies have not arrived in time to lay the information before the Association.

The accident of praus being tempest-driven from the shores of the Malay Islands, is probably one of not unfrequent occurrence, although few of them may reach Madagascar. Shortly after the restoration of Java, in 1816, the late Captain Robinson, of the Indian Navy, picked up a small fishing-boat, having on board two Malay men and a woman, 800 miles from the nearest Malay shore; and being a gentleman well acquainted with the Malays and their language, he could have made no mistake about nationality.

The occasional arrival in Madagascar of a shipwrecked prau, might not, indeed, be sufficient to account for even the small portion of Malayan found in the Malagasi; but it is offering no violence to the manners or history of the Malay people, to imagine the probability of a piratical fleet, or a fleet carrying one of those migrations, of which there are examples on record, being tempest-driven, like a single prau. Such a fleet, well-equipped, well-stocked, and well-manned, would not only be fitter for the long and perilous voyage, but reach Madagascar in a better condition than a fishing or trading boat. It may seem, then, not an improbable supposition, that it was through one or more fortuitous adventures of this description, that the language of Madagascar received its influx of Malayan.

Respecting the probable era of such adventures, we have just one faint ray of light. With the Malayan, there came in a few words of Sanscrit, such as are popular in the Malay and Javanese. From this it may be fair to infer, that the chance migrations I have supposed, whether they had before taken place earlier or not, may have taken place, at all events, as early as the epoch of the connection of the Hindoos with the Indian Archipelago,—a connection, the commencement of which cannot, I think, be placed later than the birth of Christ.

I have, finally, to attempt an explanation of the manner in which Malayan words may have found their way into the languages of the Pacific. The proportion of Malayan words in the Polynesian, judging by the New Zealand dialect, is no more than 20 in 1000, while in that of the Sandwich Islands it does not exceed 17. Except in these few words, there is nothing in common between those who speak the Malayan language and those who speak the Polynesian. Their races are different, and their languages distinct.

Conquest and settlement by the Malays, Javanese, or other tribes of the Archipelago, had probably, therefore, nothing to do with the dissemination of the Malayan in the languages of the Pacific. I have no doubt, then, that, as in the case of the language of Madagascar, it was brought about by the work of tempest-driven praus or fleets, and gradually, and step by step, from island to island, transmitted, in the course of ages, to the Sandwich Islands north of the equator, to New Zealand south of it, and as far as Easter Island.

The trade-winds are the seeming obstacle to this communication; but when the question is duly examined, they do not prove to be so. The south-west monsoon, to the north of the equator, extends to the Marianne Islands, and the 145° of east longitude; and the north-west monsoon to the south of the equator, as far east as New Guinea; while westerly winds are frequently experienced in the Pacific far to the west of this island. This is the statement of the accurate Captain Horsburgh.*

La Perouse goes farther, and observes, that westerly winds are, at least, as frequent as east in the Pacific in a zone of 7° on each side of the equator, and that the winds are so variable, that it is little more difficult to make a voyage to the

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* Horsburgh's East India Directory.

eastward than to the westward.* The testimony of Captain Fitzroy is to the same effect.†

But it is further ascertained, that the monsoon "(the western) is occasionally experienced through all the islands of Eastern Polynesia,"‡ Captain Beechy, in his instructive narrative, informs us that he picked up at sea a tempest-driven canoe, belonging to Chain Island, three hundred miles east of Tahiti, and subject to it. She had been on a voyage to the latter, and by two successive gales from the westward, was driven 600 miles out of her course, to Barrow Island, in about the 20th degree of south latitude. When rescued, she had on board twenty-eight men, fifteen women, and ten children; in fact, the nucleus of a little colony.

Captain Wilson found, when wrecked on the Pelew Islands, in the 8° of north latitude, and the 135° of east longitude, three Malay mariners; and, having among his own crew a Malay interpreter, he was able to communicate with the natives through these Malays, who had acquired the Pelew language. The account which they gave of themselves was, that in a voyage from Batavia to Ternate, one of the Moluccas, touching at Menado in Celebes, they were driven by a storm on the Pelew Islands. One of them, however, who accompanied Captain Wilson to England, acknowledged that he and his companions were part of the crew of one of three piratical praus.

Casual wrecks like this might easily have carried the Malayan language to the most westerly of the islands of the Pacific, within the tropics; while adventurers, like that of the Chain Island canoe, would, in the lapse of ages, convey it, step by step, to Easter Island and the Sandwich group.

This explanation would sufficiently account for the dissemination of the Malayan language over the tropical islands of the Pacific; but, it must be admitted that there are greater difficulties in respect to the large islands of New Zealand,

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* La Perouse, vol. ii.

† Narrative of the Surveying Voyages of the Adventure and Beagle, by Captain Fitzroy, R.N.

‡ Voyage to the Pacific in 1825, &c. &c., by Captain Beechy, R.N. London, 1831.

the nearest portion of which is 35° from the equator, and, consequently, within the region of variable winds and tempests.

The same difficulty, however, it should be observed, exists in attempting to account for the fact of the New Zealand islands being peopled, throughout, by the Polynesian race, speaking the Polynesian language. By some means or other, practicable to a rude people, an intercourse, we may be quite sure, took place between these islands and the intertropical ones inhabited by the same race of men, speaking the same language—since men are no more born with language than with mathematics—are born, in a word, only with a capacity to acquire both, equally branches of acquired knowledge. For New Zealand, then, notwithstanding the difficulties of the voyage, whether from the Malay Archipelago, or between it and the intertropical islands of the Pacific, tempest-driven praus, or fleets of praus, are our only resource for a rational explanation.

A brief examination of the cultivated plants and domesticated animals of the Polynesian Islands, on their first discovery by Europeans, may, perhaps, be thought to throw some light on the mode in which their languages received an infusion of Malayan.

The following were the plants,—the cocoa-nut, the bread-fruit, the yam, the batata, the taro, the sugar-cane, the orange, the banana, the bamboo, and the paper-mulberry. Every one of these is a native of the Indian Archipelago; but if the Malayan nations brought them, they did not bring the names, with two trifling or partial exceptions. The cocoa-nut is known by a Malayan name in the Polynesian dialect of the Sandwich Islands, but not in the Marquesas. It has the same Malayan name also in the Negro languages of New Caledonia and Tanna, but not in the Malicolo. In the New Caledonia alone, I find the Malayan name for a yam written *ufi*, for *ubi*. In the Tanna and Malicolo, these are different ones.

Rice, with all the numerous pulses, and esculent vegetables known in the Indian Archipelago, were not found in the islands of the Pacific; and, with the exception of the banana and orange, the numerous fruits of that region were wanting.

The domesticated animals found in the South Sea Islands were only the hog, the dog, and the common fowl. In none of the languages, either of the brown, or negro races, are the names of these animals, Malay, Javanese, or of any other language of the Archipelago, except that of the Marianne Islands, in which is found the Javanese word *manuke*, "a bird" or "fowl," the name for the common poultry in the Philippine languages.

Among the most frequent of the domesticated animals of the Malayan Archipelago are the goat, the cat, and the duck; and had an easy communication existed between it and the islands of the Pacific, they must, from their hardiness, have been introduced; but they are all three wanting.

The absence of Malayan names for both plants and animals, supposing the plants and animals to have been derived from the Indian Archipelago, would be the more remarkable from the frequency of the same name, for these objects, in the different Malayan languages themselves. Thus, for the domestic dog, the Javanese name is found in ten other languages, and the Malay name for the domestic hog in forty others. The name for the yam and for the sugar-cane is almost as often repeated from one extremity of the Archipelago to the other as that of the hog.

From the absence of Malayan names for plants and animals, and the absence of hardy plants and animals that might, in a transit of ordinary facility, have been introduced from the Malayan Archipelago into the islands of the Pacific, I must infer that neither were introduced by the means through which the Malayan language was communicated to those of the Pacific. I conclude, on the same ground, that the voyages were fortuitous and precarious, such as I have fancied them. Had the plants or seeds of plants, and the animals, been even on board the storm-driven praus, it is certain they must have been devoured by the famishing crews as food.

Although all the domesticated animals and cultivated plants of the Islands of the South Sea, are common to the Malay Islands, and all, I believe, indigenous in the latter, I think it, on the whole, more probable that they were indigenous also in the former, than that they were introduced from any quarter, and consequently that the culture of the one, and the domestication of the other, were native arts.

The hog and dog of the South Sea Islands are very peculiar varieties. The hog is said to resemble the Chinese breed, having a short body, short legs, a belly hanging almost to the ground, and erect ears. The dogs have "a prodigious large head, remarkably little eyes, pricked ears, long hair, and a short bushy tail." This is neither the hog nor dog of the Malayan islands in the wild or domesticated condition.

All the domesticated animals are very unequally distributed over the South Sea Islands. The hog, the dog, and common fowl are all three found only in the Society and Sandwich groups. New Zealand has the dog only. The Marquesas, the Friendly Islands, and New Hebrides, want the dog. Easter Island and New Caledonia have only the common fowl. This last alone is general.*

This irregularity of distribution is remarkable, and would seem to point at the precarious nature of the communication through which so many of the islands have been peopled by the same nation; for, had the intercourse been one of ordinary facility, it cannot be doubted but that the emigrants would have carried along with them their usual domesticated animals, in the entireness of their number.

The animals of the islands of the Pacific, now existing only in the domesticated state, may, then, once have existed, in some of them, in the wild one, and, as in other countries, been exterminated in the progress of population. The hog and common fowl in the wild state are certainly found in some of the Malayan islands much smaller than Tahiti or Owaii, from which, at the same time, the large quadrupeds, the ox, the buffalo, the rhinoceros, and the tiger, are excluded.

Still, it must be admitted that this branch of the subject is full of difficulties. The Sandwich Islands, to the north of the equator, had the hog, the dog, and common fowl, while

* Forster's Observations on Cook's Voyage.

the Marianne group, also to the north of the line, and by 50° of longitude nearer to the Archipelago, had neither the hog nor dog, and probably not even the common fowl. On the other hand, the common fowl, in the wild, but not the domesticated state, was found in the Pelew Islands, on the same side of the equator.*

The objections to the hypothesis which some have maintained that the hog and dog may have been introduced by European shipping, in comparatively modern times, are, that there is no record of any such event down to the time of Cook—that the varieties of the animals in question are different from any known European varieties—that they are the same throughout—that the names of the animals are neither European, nor have reference to a European or other foreign origin; but that, on the contrary, they are native, and the same throughout, wherever the Polynesian language is spoken, New Zealand alone excepted, in so far as concerns one animal, the dog.

The Marianne Islands, when discovered, were found destitute of nearly all the domesticated animals. The Spaniards introduced the ox, the horse, the ass, deer, goats, the dog, the hog, and the cat, some of which have since returned to a state of nature. Here we have evidence of foreign, and even of European introduction. The cat is called *keto* or *gheto*, evidently a corruption of the Castilian *gato;* and the dog is called by a compound epithet, meaning "foreign animal."† There is nothing like such evidence, historical or philological, in the languages of the Pacific.

I shall conclude with a brief recapitulation of the results at which I have arrived in this essay.

The races of men referred to in the inquiry do not consist, as commonly supposed, of one brown-complexioned, and one negro race, but of several of both.

The inhabitants of Madagascar are Africans, and wholly distinct from all the inhabitants of the Malay Archipelago or Pacific.

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* Freycinet, Voyage autour du Monde; Wilson's Account of the Pelew Islands.
† Ibid.

There are many languages essentially distinct from each other, both of the brown-complexioned and negro races, and not one only of each of these two, as generally supposed.

Except in the case of the Malay in the Archipelago, and the Polynesian in the Pacific, there are no wide-spread languages or dialects.

As far as our scanty knowledge of the Negro languages will enable us to judge, the only clear distinction between them and those of the brown-complexioned consists in the first containing always more consonants in proportion to vowels, and more harsh combinations of consonants than the latter.

It is chiefly the Malay and Javanese, the languages of the two most powerful, civilized, and enterprising of the Archipelago, which is found in other tongues, from Madagascar to Easter Island, and from Formosa to New Zealand.

The evidence for this exists in the words themselves, and their being pure and numerous as we are near Sumatra and Java, the original countries of the Malay and Javanese nations, and corrupt and unfrequent as we recede from them, until, the barrier becoming insuperable, they disappear altogether.

The superior civilization of the people of the countries of the Asiatic continent has excluded Malayan from their language; a grovelling condition of society has excluded them from those of the tribes of Australia; and insuperable physical obstacles from those of America.

Within the Malayan Archipelago the Malay and Javanese languages have been communicated to others by conquest, settlement, or colonization, and commerce; while to Madagascar, and the islands of the Pacific, they have been communicated by the accidents of tempest-driven praus or fleets of praus.

The insular character of the whole region over which a Malayan language has been disseminated, and the periodical winds prevailing within it, which, on a superficial view, appear obstacles, are, in truth, the true causes of the dissemination; for, had the region in question been a continent, stretching north and south like America, or lain within the latitudes of variable winds and storms, no such dispersion of one language could have taken place.

Such is the most rational explanation I can render of a fact in the history of our race, mysterious without explanation, and wonderful enough even with it.

Notice of some Plants which have Flowered recently in the Edinburgh Botanic Garden. By J. H. BALFOUR, M.D., Professor of Botany in the University of Edinburgh. Communicated by the Author.

STENOCARPUS* CUNNINGHAMI, *Hook.*—Nat. Ord. Proteaceæ.—Tetrandria Monogynia.

GENERIC CHARACTER.—Perianthium irregulare, foliolis distinctis, secundis. Stamina apicibus cavis foliolorum immersa. Glandula hypogyna unica, semi-annularis. Ovarium pedicellatum, multiovulatum. Stylus deciduus. Stigma obliquum, orbicularo-dilatatum, planuisculum. Folliculus linearis. Semina basi alata.—Frutices glaberrimi. Folia alterna integerrima. Umbellæ axillares vel terminales, pedunculatæ. Flores ochroleuci (v. aurantiaci.) *Br.*

Linn. Trans. x., 201. Prod. Fl. Nov. Holland., 341. Supp. 34.

SPECIFIC CHARACTER.—Foliis amplis, obovato-lanceolatis, integris, sinuatis pinnatifidisve, floribus umbellatis sericeo-aurantiacis.—*Hook. Bot. Mag.* 4263. Agnostus sinuatus, *All. Cunning.*

It belongs to the genus *Cybele* of Knight and Salisbury. *Prot.* p. 123. *Species Embothrii.* Forst. *Gen.* 16.

The plant in the Botanic Garden is a *small tree* about 20 feet high, erect, stem 2½ inches in diameter, branching at the upper part, and bearing evergreen foliage at the end of the branches. *Leaves* alternate, petiolate ex-stipulate, coriaceous, shining, usually sinuate or pinnatifid, sometimes undivided, in their general circumscription cuneate, glabrous, 12 to 18 inches long, feather-veined, and beautifully reticulated, having numerous stomata. *Inflorescence* umbellate. Umbel axillary or terminal, and stipitate, with from 12 to 15 radii. General expansion of floral clusters

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* στενὸς narrow, and καρπὸς fruit.

centrifugal. In some of the specimens, the stalked umbels proceeded singly from the axil of leaves; in others the flowering branch ended in a cluster of pedunculated umbels, giving rise to the appearance of a compound umbel. This depends on a shortening of the branch, the leaves of which, in place of being alternate, became opposite, and the flowering stalks thus came off nearly at the same point. *Involucre*, consisting of numerous small triangular deciduous scales or bracts, one of which is at the base of each pair of flowers. *Peduncles* covered with brownish or golden hairs. The extremity of each of the peduncles is curved downwards abruptly, the apex forming a circular flattened disk. Flowers obliquely attached to short pedicels about half an inch long, arranged in a circular manner round the extremity of the peduncle. *Alabastrus* of a clavate form, the extremity being rounded or knob-like. *Sepals* four, valvate, at first opening between the claws, and cohering by their capitate or clavate apex, afterwards opening entirely, and becoming revolute, three of them curving downward and one upward, thus giving a subsecund aspect, of a pale-orange colour outside, and of a fine orange scarlet within, hypogynous, linear-clavate, lower half of nearly uniform breadth, upper becoming narrower, and gradually tapering towards the ovato-triangular hollow, spoonlike, obliquely attached extremity, which is of a yellowish colour. Sepals and pedicels covered with short minute, appressed brownish hairs, some of them conical, others clavate. *Anthers* four, supported on short stalks, which are inserted in the lower part of the concave apices of the sepals. *Pollen* triangular, extine reticulated. *Ovary* covered with silky brown hairs, supported on a long stalk or thecaphore, which is equal in length to the style, and has a dark-red adherent scale, partially surrounding its base; unilocular, with three ovules attached to a parietal placenta. *Style* one inch long, curved nearly at right angles from the apex of the ovary, tapering, ending in an oblique shield-like apex, bearing a large subconical *stigma*, which is covered with pollen when the sepals expand. *Ovules* amphitropal. *Fruit* has not been perfected in the Garden. It is said to be a terete follicle, about the size of the little finger, apiculate, woody, chocolate-brown, and containing seeds which are winged at the base.

Hooker states, that this plant was discovered in 1826, by Allan Cunningham, on the banks of the Brisbane River, Moreton Bay, but as he did not see the flower, he gave no description of the plant. Two rooted plants were sent to Kew, and from them the plant has been distributed over the country. The plants in the Kew Garden have attained the height of 16 feet, but have not flowered.—In the Glasgow Garden there is a plant about the same size. In October 1846, the plant flowered in the Edinburgh Botanic Garden. Sir William Hooker has figured a specimen from the greenhouse of the United Gardeners' Society, King's Road, Chelsea; and he remarks, that it is probable that the great heat and much sun of the season has contributed to the flowering. The plant has flowered also in the Birmingham Botanic Garden, under the care of Mr Cameron. The flowers are very showy.

Exogonium Purga, *Benth.*—The True Jalap plant.—Convolvulaceæ.—Pentandria Monogynia.

Generic Character.—Sepala quinque. Corolla tubulosa, stamina exserta. Stylus 1. Stigma capitatum, bilobum. Ovarum biloculare, loculus bi-ovulatus.—Herbæ aut suffrutices, volubiles, America ortæ. *Choisy*, Mem. Soc. H. N. Genev. vi., 404.

Specific Character.—Foliis cordatis, acuminatis integerrimis, utrinque glabris, pedunculis 2-3 floris, tubo corollæ calycem obtusum quadruplo superante, limbo hypocraterimorpho, lobis obtusis, sub-emarginatis.

Ipomœa Purga, *Wenderoth*, Pharmac. Centralb. I. p. 457. *Choisy*, Dec. Prod. ix., 346. *Lindley*, Flora Medica, No. 809. Bot. Reg. Misc. 1839, No. 136, and Sept. 1847. *Nees ab Esenbeck*, Pl. Off. Suppl. 3. t. 13. *Hayne*, Darstell. und. Beschreib. der in All. Arzneikunde Gebrauchl. Pflanzen. 1833, t. 33, 34.

Ipomœa Schiediana, *Zuccarini* Flora, 1831, p. 801. Abhandl. Bajer. Acad. Wissenschaft, 1832.

Ipomœa Jalapa, *Nuttall* and *Coxe*, American Journal of Med. Sciences. February 1830, t. 7. *Royle*, Ill. Himal., p. 308. (non Pursh.)

Exogonium Purga, *Benth.* Pl. Hartweg, 46. Bot. Mag. Feb. 1847.

Convolvulus Jalapa, *Schiede* in Linnæa, 1830, p. 473.

Tuber roundish, becoming as large as a moderate-sized turnip, brown externally, whitish internally, giving rise to numerous rootlets and stems. *Stem* twining from right to left, spirally twisted, glabrous, marked with numerous ridges and furrows (20 or more), branching, more or less purplish-red, extending 10 or 12 feet. *Leaves* alternate, ex-stipulate, petiolate, cordate or sagittato-cordate, deeply lobed at the base, acuminate, entire, glabrous on both sides, slightly rugose, dull green above, paler or subglaucous below, reticulated, veins radiating at the base, prominent on the lower surface of the leaf, and channelled on the upper. *Petioles* about 2 inches long, shorter than the leaves, striated, grooved above, rounded below. *Peduncles* reddish, axillary, erect, twisted, wiry, about 1½ inch long, 2-3 flowered (rarely 1 flowered), with a small triangular bractlet at the base of the pedicels or partial flower-stalks, which are about quarter of an inch long, and thickened upwards. On making a section of the pedicel near its upper part, the cellular tissue in the centre was found to be arranged in a stellate manner. *Inflorescence* definite, expansion of flowers centrifugal. *Calyx* glabrous, of five somewhat elliptical, obtuse, concave, adpressed sepals, membranous at their margins, the two outer ones smaller. *Corolla* shining, glabrous, between funnel-shaped and salver-shaped, of a fine purplish red colour; tube slightly contracted at its junction with the limb, then widening and ultimately tapering downwards, about 2 inches long, four times longer than the sepals, purplish-red outside, and of a whitish colour within; limb expanded, slightly revolute at the margin, 2½ inches across, plaited or undulated, of five blunt slightly notched lobes and shallow sinuosities between them, the union of the petals marked by two lines, prominent on the lower side, uniting at the margin of the limb, and enclosing a triangular space; spiral vessels distributed through the substance of the corolla. *Æstivation* contorted. *Stamens* 5, colourless, exserted beyond the tube and towards one side of the throat, shorter than the limb; filaments unequal in length, from 2 to 2½ inches long, inserted near the base of the tube of the corolla, flattened at their union with the corolla, tapering towards their antherine extremity, with scattered hairs and tooth-like projections towards their lower half; anthers 2-lobed, opening by longitudinal dehiscence, innate, introrse; pollen spherical, extine marked with numerous prominent processes. *Pistil* rather longer than the longest stamens; stigma colourless, 2-lobed, capitate, tubercular, *i. e.* covered with numerous projecting cellular processes; style about 3 inches long, slender, tapering; ovary superior, conical, gradually ending in the stigma, surrounded at its base by a thickened annular disk of a yellowish colour; 2-celled, with two ovules in each cell; ovules somewhat trigonous, anatropal.

The plant evidently belongs to the genus Exogonium of Choisy, as defined in De Candolle's Prodromus, although the author places it under the genus Ipomœa, from which the exserted stamens at once distinguish it. The following are the definitions of the allied genera, as given by Choisy:—

A—Ovary 3-4-celled, each cell having 2 ovules.

1. *Pharbitis.*

B—Ovary 2-celled, each cell having 2 ovules.

2. *Convolvulus*, stigmata linear, cylindrical, stamens included.

3. *Jacquemontia*, stigmata ovate, flattened, stamens included.
4. *Ipomœa*, stigmata capitate-globose, stamens included.
5. *Exogonium*, stigmata capitate-globose, stamens exserted.

Schiede found the plant at a great elevation on the eastern slope of the Mexican Andes, near Chiconquiaco; and also on the eastern slope of Cofre de Perote. He gives an account of his discovery in the Linnæa for 1830. Hartweg, it appears, has also found the plant in Mexico, and it has been described by Bentham from his specimens.

Although jalap has been used in European medicine for nearly two centuries and a half, it is only within a few years that its botanical source has been correctly ascertained. The plant long cultivated as the true jalap-plant in the stoves of Europe, and, among the rest, in the Botanic Garden of Edinburgh, is the *Convolvulus Jalapa* of Linnæus and Willdenow, or *Ipomœa macrorhiza* of Michaux, a native of Vera Cruz. But between the years 1827 and 1830, it was proved, by no fewer than three independent authorities, M. Ledanois, a French druggist, resident at Orizaba in Mexico; Dr Coxe of Philadelphia, through information supplied by M. Fontanges, an American gentleman who resided at Jalapa; and Schiede, the botanical traveller, from personal examination, —that the root of commerce is obtained, not from the hot plains around Vera Cruz, but from the cooler hill country near Jalapa, above 6000 feet above the level of the sea, where it was exposed to frost in the winter time; and that the plant which yields it, is an entirely new species of the Convolvulacæ. Schiede introduced the plant for the first time into Europe; and it has been cultivated in various botanic gardens of Germany. In this country it was probably first cultivated in the Botanic Garden of Edinburgh, from a tuber sent by Dr Coxe of Philadelphia to Dr Christison, in 1838. Dr Graham could not describe it at that time, because, owing to unacquaintance with the habits of the plant, it was forced in the stove, and died the same year, after forming numerous flower-buds, of which one only became partially developed. In 1844, a plant from the Chelsea Botanic Garden, cultivated in a cold frame in the Edinburgh garden during the winter and spring, and uncovered in the summer and autumn, flowered luxuriantly in September. But the crown of the tuber was injured by frost in the subsequent winter, and the tuber was thus killed. A drawing was taken by Dr Graham, but it has not been found among his papers. Ultimately, Mr M'Nab resolved to try whether the plant could be raised from slips; and the experiment has proved completely successful. A tuber, of the size of a hazel-nut, formed in the course of three months. The stem made little progress the next summer; but when transferred to the cold frame in the spring of 1846, formed the plant which flowered in October, from which the description has been taken. Some still maintain that the plant requires a stove-heat to make it flower. In the Botanical Register for September 1847, the following remarks are made in regard to it :—" In cultivation this should be regarded as a stove herbaceous climber, which grows freely in a mixture of sandy loam and leaf mould in equal portions." In the Botanic Garden of Edinburgh, the plant continues to thrive in a cold frame, as already mentioned.

Memoir on the Changes in the mean direction of the Wind, in the Annual Period, in North America. By M. Dove.

As there is no point on the surface of the earth where the atmospheric pressure increases or diminishes without interruption, we must suppose that, as within the tropics, the quantities of air which move below, towards the equator, consist of a current running in a contrary direction to that above; just as two currents which advance by the side of each other, in the temperate zone, form an equilibrium, in such a manner that the one which, in the space of a year, moves towards the pole on certain points of a parallel, returns in an opposite direction to the equator on other points of the same parallel. At the same time, as the air which moves from the equator towards this parallel, arrives at it with a higher temperature which it gradually leaves in the ground over which it passes in its progress towards the pole, a temperature which it does not restore to the parallel on its return from the pole to the equator, because cold air occupies a smaller space than warm air ; it thence follows, that the polar current must be weaker than the equatorial current. If the movement in the one direction or the other has taken place in variable strata, it is thereby rendered probable, that a place exists in the polar current weaker than that in the equatorial current, and, consequently, that the mean direction of the wind, from this cause alone, ought to be equatorial throughout the whole temperate zone. Besides, as the quantity which returns to the equator is less, because the elastic accompaniments on the air or steam is more and more condensed in its progress to the pole, the returning air is deprived of an elastic element which returns to the equator or to its origin, under the form of liquid water, so that there is a double cause to which we may ascribe the mean direction of the wind to the south-west, in the northern temperate zone, and to the north-west, in the southern temperate zone. It is evident, that what has been said as to the mean direction of the wind does not apply to its compounds, that is to say, that at a determined period of the year, it must necessarily happen, that the same parallel should be traversed by winds in a contrary direction. It is not less evident, that it must be extremely difficult, in consequence of the multiplicity of directions observed, to demonstrate the compensation which must take place in each case. This fact, at the same time, had always been, indirectly, rendered very probable by the climateric circumstances of localities placed at short distances from each other, in the work which the author has undertaken on the periodical changes in the distribution of the temperature at the surface of the earth, for upwards of a century, principally between the American and European stations; but it was desirable to see this compensation confirmed in a direct manner.

A great number of monthly directions of winds, calculated by MM. Schübler, Kaemtz, Wenckeback, Kupfer, Haellstrœm, and the author, have demonstrated that in Europe, the direction of the wind, which in winter is south-west, is changed in summer into a north-west direction, again returning to the south in autumn. According to the causes explained above, there cannot be, in all the temperate zone, a north-west direction of the wind simultaneously in all the places of the same parallel, since at all epochs the south winds must predominate over those of the north. It is necessary, therefore, in order that compensation take place, that the periodical changes should be opposed to those of Europe. This is precisely the case with regard to North America, where the south-west direction of the wind prevails in summer, and the north-west in winter. It would occupy too much space to give here the tables and formulæ which the author has employed to demonstrate the existence of this phenomenon.*

* From L'Institut, No. 711, p. 169.

New Diluvian Formation of the Vosges.

M. De Billy read a memoir on an argillaceous diluvian formation observed in the department of Vosges.

The author distinguishes four classes of diluvian formations in the department of Vosges, namely,—

1. The granitic diluvium, composed of pebbles and sands produced by the disintegration of granites, gneiss, porphyries, and other ancient rocks. 2. A deposit, composed of the debris of Vosgian sandstone in the state of sand, quartzy pebbles, angular fragments, and blocks of this secondary sandstone. 3. An argillo-sandy diluvium, very frequently filled with rounded quartzy pebbles. 4. Argillaceous deposits formed in the middle of Jurassic formation, and mixed with a greater or less abundance of fragments of secondary limestones.

The work which M. De Billy communicated to the Society is devoted to the third class of diluvium.

This deposit is principally composed of an argillaceous earth, sometimes sandy, more frequently plastic; the colour varying from light-grey to greyish-yellow, and to yellowish-grey inclining to red. We generally find in it that kind of quartzy pebbles everywhere so abundant in the Vosgian sandstone. It sometimes happens, however, that the clay is quite free from them. The localities where this argillaceous diluvium has been observed are along the numerous water courses which furrow the northern region of the department of Vosges. It is noticed sometimes at the level of the present waters, and even below them, sometimes a little above; and lastly, and this case is frequent, covering the plateaux which overhang the valleys, and in which the waters may be supposed to have deposited them when they were of larger size, and ran at a higher level than in our days. These currents of water, beginning at the east, are the Mortagne Arentelle, Durhion, Moselle, and the Aviére. The thickness of the deposit, which frequently varies between 20 and 50 metres, reaches a height of 124 metres on the banks of the Moselle, as in the neighbourhood of Charmes.

This observation is of some interest, on account of the inferences which may be drawn from it. It proves, for example, how other sedimentary masses, which, on account of their thickness or level, we were unwilling to ascribe to the action of running water, may be referred to that agent without fear of exaggeration.

The author regards the deposit of which he treats as the result of the decomposition of Vosgian sandstones. He is led to this conclusion, both by the facts passing under his eye, and by the topographical position of the diluvium, which is below a mass of Vosgian sandstone deeply furrowed, almost even destroyed at many points, which extends very nearly north-east and south-west from the valley of Meurthe, near St Die, as far as that of the Moselle near Epinal.

The age of this formation, when compared with other deposits of the same epoch, cannot yet be determined with any degree of precision.

In certain cantons, this diluvian deposit has a very marked influence on agriculture. It often appears to be very favourable to the growth of forests. Sometimes, by retaining the water on the surface, it gives rise to springs. When not mingled with pebbles, it is used for the purposes of making pottery, most frequently tiles and bricks. When the pebbles, on the contrary, are very abundant, it is dug for the purpose of mending roads. This formation has, therefore, a certain degree of influence on the support of the people, their modes of building, and the channels of communication ; and if it be not of great importance in consequence of its mass and extent, it is among the number of those which have a direct effect on the inhabitants of a country.

Notices of New Publications deferred until next Number, in consequence of the indisposition of Professor Jameson.

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THE

EDINBURGH NEW
PHILOSOPHICAL JOURNAL.

On the Comparative Geography of the Arabian Frontier of Egypt, at the earliest epochs of Egyptian History, and at the present time. (With a Map.) By Miss FANNY CORBAUX.

(Continued from p. 42.)

We have yet to account for the disappearance of the northern half of the Etham river, for it seems to have been destroyed piecemeal, as its partial substitute, the sea-canal, was made; and unless the suppression of this portion also had been effected before the time of Herodotus, he undoubtedly would have mentioned the river among the arms of the Nile he enumerates; for Necho's canal only changed a part of its course, but that work did not accomplish its final excision, though it certainly was the first step towards it. Instead of flowing along a natural channel from Scenæ to Hero, it now ran along an artificial bed from Bubastis to Hero, and all the rest of its course, through the Crocodile lakes towards Magdolum and the sea, remained as yet unaltered.

If our inquiry had had no other purpose in view but to prove that in the lost arm of the Nile whose history we have begun, a natural supply of water existed during the Mosaic period, sufficiently ample to account for the existence of cities in the localities suggested by Mr Sharpe as the sites of the Mosaic stations, we need not have pursued the subject farther; for we must by this time be content as to a fact proved by such unquestionable natural indications, that although the suppression of this river originated in Necho's time (nine centuries after Moses), it is not even now naturally extinct.

Thanks to the phenomena brought to light by the flood of 1800, there is no difficulty in proving its existence. The only difficulty is to find satisfactory reasons to explain its absence!

But there is another desideratum, without which this geographical theory would hardly be complete. As it requires that the Red Sea should have retired from its primitive head *since the time of Moses*, it will be very interesting to ascertain the precise period of its retiring. Now, the solution of this problem is so connected with the history of the ancient canal made to connect the Nile and the sea, and the history of this canal is, in its turn, so inseparable from that of the river it partly supplanted, that by following up the subsequent destinies of the river, we shall arrive at all we wish to ascertain on the other points. The history of that river affords the only clue to guide us out of the labyrinth of perplexity in which we are entangled by the strangely discordant accounts given by ancient authors concerning the canal, of which Major Rennell so pithily remarks, that "if we credit Herodotus, Darius finished it; if Diodorus and Strabo, Ptolemy alone completed it; and if Pliny, it was never finished at all!"

As Herodotus, who wrote within eighty years of the reign of Darius, having himself visited Egypt on purpose to gather information, distinctly, and in several places, tells us that the canal *was finished* by Darius—that "it entered the Red Sea," "was discharged in the Arabian Gulf,"—and, again, in another place, refers to the "Arabian Gulf into which Darius introduced a channel of the Nile,"* we cannot doubt that such was the case, without setting aside the most unequivocal kind of testimony,—that of a contemporaneous historian and eye-witness, who is generally found faithful in his relation of what he observed. The *subsequent retiring of the sea* may have rendered necessary the additional operations historically attributed to Ptolemy Philadelphus and to Trajan; but to doubt that, in the time of Darius Hystaspes, the junction of the Nile with the Arabian Gulf, as far as it extended,

* Herodotus, Euterpe, clviii. Melpomene, xxxix.

had been virtually effected, would be carrying scepticism beyond reasonable bounds. Some later historians than Herodotus certainly do seem to treat of it as *not* finished by Darius; but where we find conflicting accounts of a matter of fact, we must estimate the authority of a witness according to his means of information, weigh it with other facts, and decide accordingly. The *subsequent retiring of the sea* will prove the means of harmonizing the discrepancies their accounts exhibit; and as the sequel will shew how the mistake of the ancient authors here adverted to, finds an easy and natural explanation by this hypothesis, we may, for the present, safely admit the distinct statement of Herodotus—that the canal in his time was finished up to the sea—as *an historical fact*, and a fixed point to start from in the succeeding inquiry.

We must now revert to the configuration of the district along which this famous canal was led, and convince ourselves, by a critical analysis of its external features, that, although we have, on the one hand, this positive historical fact, that Darius joined the Nile to the Arabian Gulf, we have, on the other hand, an equally positive physical fact, that to do this, without intercepting the northern half of the river, would have been impossible;—as impossible as for Necho to have made his canal along the valley of Etham, without first intercepting the southern half.

Every body knows that if water runs off down a slope to a much lower level, the general level of the water will correspond with that slope, and therefore its height, at the end of its course, will be about as much less than that of the original fountain, as the amount of the incline downwards.* But if, instead of being thus allowed to run off, the course of the water is dammed up, then the water-line will no longer correspond with the slope—it will rise to the level of the original fountain, and become horizontal.†

When the waters rose to 4 feet 6 inches above the bed of the ancient canal, and within 3 feet 9 inches 9 lines of the top of the granite block at Moukfar, during the irruption of

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* *Vide* Plate VI., diagram B, line ABB. † Ibid., line AA.

1800, they had already suffered a great loss in height. The perpendicular height of the Nile near Bubastis, and consequently in the corresponding place of the plain of the Delta near Abbasieh, must have been one foot below the level of the Red Sea. But at Moukfar, it was 11 feet 3 inches 11 lines below the same mark.* This great loss is explained by the fact that immediately beyond Moukfar, the water began to shew the remarkably rapid downward current already referred to; a current far exceeding that of the natural course of the Nile in velocity,—(M. Devilliers estimates it at 4 feet per second), proving the truth of M. Le Père's remark, " que les eaux avaient trouvé des terrains beaucoup plus bas sur lesquels elles se répandaient."†

It is therefore obvious, that if, at the present time, and during *an excessive flood*, the Nile is already lower than the sea at Bubastis, where, in the time of Darius, the canal began,—it must have been utterly inconsistent with such a project as Darius is said to have executed, to allow of any further waste of height, at a period when a similar flood must have fallen considerably short of the same mark.‡ To carry

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* *Vide* Sect. 2., Plate V., for the height of an ordinary inundation, on the diagram of Canal Moëz. *Vide* also diagr. B., Plate VI.

† Descr. de l'Egypte, Mém. of M. Dubois-Aymé, vol. xviii., App. p. 349, 350, and Journal of M. Devilliers, ibid.

‡ On the supposition that the increase in height of the land, at Cairo, is 36 feet English in 1000 years, the increase in the region of Bubastis would be about 27 inches in the same time. For we may suppose that (*cæteris paribus*) the average amount of sedimentary matter deposited by running water in a given place will be proportional to the depth of the water. At Cairo, in a good inundation, the Nile swells to 24 feet above its lowest point. At Bubastis, it swells to nearly 18. Therefore, were it not for secondary circumstances, which rather tend to reduce the bulk of the deposits, the nearer the formations are to the sea, the gain of land at Bubastis would be to that at Cairo as 3 to 4; and the soil at Cairo, in the time of Necho, 617 B. C., being 90 inches lower than it is now, the Nile accordingly must have risen there by so much less, with respect to the invariable level of the Red Sea. According to this proportion, at Bubastis, where Necho's canal began, the difference would be 67½ inches, as delineated in diagram A, Section 1., Plate V.

But owing to the secondary circumstances above alluded to, (which need not be detailed here), we are likely to be much nearer the truth if we allow the gain to be less by about 16 inches, than strict computation would make it. This is the standard adopted for the comparative proportions of the Nile exhihis plans into successful execution, he must keep up the level of the water in his canal to about the point it had at Bubastis. He must both dam up the water, and stop up the outlet into the low lands.

The locks and dykes through which vessels had to pass from the canal to the sea, answered the first purpose. For, of course, the canal could not run into the sea, being still a little the lower of the two;—but its water ran against the locks, as against a wall; and being thus dammed up, it could rise to the level it had at the canal's point of junction with the Pelusiac arm, " a little above Bubastis, and near Patumos,"—provided the outlet of the river through the low level of the Crocodile lakes into the still lower marshy region to the north, were previously stopped up. Otherwise, the water in the canal must have taken the slope of the lands; it could not even have risen to the point it reached at Moukfar in 1800, but would have fallen short of that by about 6 feet, owing to the additional height required by the Nile and the land during a lapse of more than 20 centuries, and also, to that year's inundation being an excessive one. If, then, the *highest* water-line obtainable during the flood season was still sixteen feet below the level of the sea, what must the *lowest* have been? This must convince us that unless Darius stopped out the river, the works historically attributed to him by Herodotus will seem impossible.

But although this is much, it is not all we want to justify a conclusion. We must find historical and physical evidence,—1°, that *such a stoppage has been effected;*—and, 2°, that *this was done at a period referable to the reign of Darius.*

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bited by the diagram B, Plate VI., shewing the end of the Etham river's course, and the levels of the waters and bed of the river at Bubastis, lowered to the times of Necho and Ptolemy Philadelphus. It joins Section 2 at the place of the scale.

It will be seen that the bed of the river is brought down to a point coinciding with the general level of the Wady Toomilat, by this calculation, which thus would have *led* to what it now helps to *confirm*—the date of the Nile's exclusion from that part of the valley, deduced from indirect historical evidence.

The lines marked N. in this diagram, shew the utmost height of the Nile at Bubastis in the time of Necho and Darius.

Those marked P. P. shew its rise in the time of Ptolemy Philadelphus.

In the absence of a definite statement that Darius did actually intercept this water-course, our clue of evidence appears very slender. Indeed it is so fragmentary, that in order to reunite the detached links of our broken chain, and so connect them as to lead us to a satisfactory conclusion, it will be necessary to make an apparent digression from the main point, to discuss two very important geographical questions, which, at first sight, may appear but remotely connected with the subject immediately under consideration.

Strabo, writing at or about the time of the Christian era, mentions certain lakes, situated somewhere in the vicinity of the Sethreitic nome, which formerly were bitter, but which in his time had been rendered sweet by the waters of the canal that led to Arsinoë being introduced into them. The first point to be settled, is to determine the site of those lakes.*

It has always been taken for granted that their site must have been the great hollow, now occupied by salt marshes, lying between the ancient Serapeum† and the neighbourhood

* He is describing the country above Pelusium in Arabia.

"*It is said* that there are some other lakes and canals in the same parts out of the Delta. Near one of these lakes is the Sethreitic nome, one of the ten that are reckoned in the Delta. Two other canals enter these lakes; one leads to the Arabian Gulf, to the city Arsinoë, which some call Cleopatris. It also flows through the so-called bitter lakes, which indeed formerly were bitter; but this canal being cut, they were made sweet by mixing with the river, and now abound with excellent fish and lake-fowls. * * * Near Arsinoë is also the city of Heroon (Heroopolis) and Cleopatris, in the inner recess of the Arabian Gulf, the one nearest to Egypt, [εν τῷ μυχῷ τοῦ Αραβίου κόλπου τῷ πρὸς Αἴγυπτον] as well as harbours and dwellings, and several canals, with lakes adjacent to them. Here also are the nome and city of Phagroriopolis. The beginning of the canal that led into the Red Sea is near Phacusa."—*Strabo's Geogr.*, Book xvii., p. 804.

This passage, which some have deemed so decisive in *settling*—or rather *unsettling*, the vexed question of the position of Heroopolis, will be found to lose much of its decisive character when thus given entire, prefaced by Strabo's own admission, that he speaks only by report of parts he had not himself visited,—and closed by the statement that the canal began near Phacusa. We cannot refuse him a corresponding latitude of meaning, or looseness of expression, when he speaks of *Hero*, on that canal, being *near Arsinoe*—especially as it was the nearest city of note, and so easily accessible by water.

† *Vide* Map, Plate IV.

of Suez. And as all arguments drawn from the passage of Strabo here alluded to, are based on this common misapprehension, it will be necessary, before we are able to conclude anything from it, to shew, *firstly*, that, at the very time Strabo wrote, and even fifty years after, the body of water formerly occupying the site of those marshes was considered a part of the Arabian Gulf: *Secondly*, and independently of this, there will be no difficulty in demonstrating that to assume the site of the marshes to have been that of Strabo's lakes, would involve the admission of several physical impossibilities.

The first of these propositions will be made evident by a critical examination of Pliny's account* of the works and dimensions of the sea-canal in his time,—more than 300 years after the operation of Ptolemy Philadelphus, and fifty years later than Strabo. After describing the Elanitic arm of the Red Sea, he proceeds thus:—

"There is another gulf, called by the Arabians Æant, on which is the city of Heroum, * * * * and the Port Daneon, from whence there is a navigable canal that leads to the Nile, traversing from this port to the Delta a space of 62 M.P., which is the distance between the Nile and the Red Sea."

These 62 M.P. will be found to correspond exactly with the interval between the Serapeum and the Pelusiac branch, if we ascend the line of navigation along the canal of Necho and Darius, to Thoum; and leaving it there, follow in a S.W. direction, another canal, which formerly joined this to the Nile a little to the north of Scenæ, and of which the remains, choked up with sand, still exist. (This is a canal opened by Ptolemy Philadelphus higher up the river than Necho's, for a purpose which will appear in the sequel). 20 M.P. along this canal to Thoum, + 24 from thence to Hero + 18 to the Serapeum = 62 M.P. Near the Serapeum are the vestiges of a small town, which I identify

* Pliny, Geog. l. vi., c. xxix.

† *Vide* Plate VI., a ground plan of this canal in its several stages, the distances being graduated according to the scale.

with the Port Daneon of Pliny—a more modern name of BAAL-ZEPHON. Nothing can be clearer, thus far, than this statement; and nothing easier than to verify its accuracy by actual measurement, since the ruins of the canal are still visible. It is 62 miles long,—it is finished up to the sea,—and *that is the distance from the Nile to the sea.*

Yet, Pliny thus continues:—" Sesostris, King of Egypt, first conceived this undertaking; afterwards Darius of Persia, after him, Ptolemy II., who dug a canal to the bitter springs, 100 feet wide, 30 deep, and 37,500 paces (37½ Rom. miles) long. *He did not finish the work for fear of inundating the country, the Red Sea being found at that place three cubits higher than the lands of Egypt.*

In what place? most unquestionably *near the sea*, wherever that might be. But Pliny seems here to contradict himself in a most extraordinary manner. He appears to forget having just told us that a canal of a certain length *was* finished up to the sea, since what immediately follows that very explicit statement, is another equally explicit statement that *it was not!*

The only hypothesis by which this contradiction can be resolved, from the unqualified absurdity that it appears, into the accurate representation of the state of things in Ptolemy's time that it really was,—is this: that a little before the reign of Ptolemy, a *new head* of the Red Sea had been formed near Suez, (*vide* section 1, 4), but that the *ancient head*, now virtually become an inland sea 20 geographical miles in length, still retained its former name; that this accident of nature had rendered necessary certain additional works, amounting to 37½ M.P., to extend the line of navigation up to the new maritime station, Arsinoë, built (according to the same account) by Ptolemy, on the "Gulf of Charandra:" that, in the first paragraph, Pliny alluded to the former head of the gulf; and, in the second, to its present one.

When we consider that the surface of the great shoal north of Suez must have been rising so slowly and insensibly, by the submarine accumulations of centuries, that no one perhaps had particularly remarked the exact period when a sand bank, which for more than 300 years had so far impeded navigation as even to be constantly laid dry at low water,* finally reached the critical point that shut out the highest tides also; there seems nothing improbable in supposing that long after the event, the force of habit may have prevailed over strict geographical precision of expression, in the denomination bestowed on the upper gulf-basin, and that it thus continued to be called "*the Sea*," in common parlance so long as it retained a sufficiently large body of water to justify an appellation it owed to long custom. And if there exists no direct historical memorial of this physical change, we must remember that the region where the obstruction took place was the most barren and inhospitable part of the Egyptian frontier; that, owing to the want of fresh water eminently characterisic of that neighbourhood, it contained no habitations but the two marine stations† recently erected, merely to serve as resting points for troops, or for commercial bands; that it consequently was out of the reach of observation from all but the traders who passed by on their way to the Indian Sea. Under such circumstances, it is not surprising that the final crisis of a physical change so gradual in its progress, should have remained unmarked and unrecorded; that the works called forth by the event being executed, the next generation forgot their immediate occasion; and that an oblique course of inferences, drawn from contemporaneous accounts too brief to admit of such explanatory details, should be the only means we have of referring its occurrence to a definite historical period.

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* The dotted lines 2 and 3 on the shoal in section 1, Plate V. are an attempt to indicate these successive stages of growth from the time of Necho to that of the Ptolemies.

† The place where ruins with Persepolitan inscriptions were seen, indicated on the map, but without a name, is one; Arsinoë itself is the other. At the time Arsinoë was built, the little inlet above Suez, which is all now remaining of the Gulf Charandra, must have been a good harbour, and navigable up to that port. It has since become so shallow, as to be fordable, with camels—the coast line having retired so much as to be nearly two miles from Arsinoë, in ordinary tides. Already in the time of the Roman emperors who completed the canal, another marine station seems to have been needed. This was "*Clysma*," a heap now known as "Tel Kolzim," a little to the north of Suez.

We cannot subject this hypothesis to a more decisive test, than that of weighing its consistency with physical and with historical fact, by considering, with the help of the diagrams which embody the physical facts, how far the details of the works, attributed by Pliny to Ptolemy, agree with the main design Ptolemy would have in view in executing those works, namely, that of keeping up as entire a line of water communication with the southern sea, as could be done with ease and safety, under the altered state of things.

The superficial communication of the main with the upper gulf-basin being now, as we suppose, cut off (*vide* section 1), the contents of the latter must have sunk a little by evaporation. Were it not for the annual supply from the Nile, introduced by Darius's canal, they would have dried up entirely; and so long as this was taken from Bubastis, where the inundation, at its greatest height, was yet six feet lower than the sea, that level is the utmost the water of the gulf-basin could attain.* Under such circumstances, the greatest part of the intervening shoal must have been laid bare (*vide* section 1, Plate V., *ante*, p. 19), and to open a communication by water as far as Arsinoë, it would be necessary to excavate about xi. M.P. along it.

Although it would be difficult to suggest how far below their maximum height the waters of the gulf-basin would sink annually by evaporation, we may be sure that the loss of so large a surface, in such a climate, would be too great to admit of a passage to Arsinoë navigable all the year, unless a very deep channel were cut in the hard nucleus of the shoal. It was easier to dig a trench of little depth in its softer surface only; and this done, to supply the whole line of navigation from a point in the Nile where the water is about 5 feet higher than at Bubastis (*vide* section 2), by conducting it from the Pelusiac branch near "Scenæ," along the Etham river's former course, where the half-obliterated bed of the river was still sufficiently marked to render excavation in that quarter unnecessary.† For high banks to lead the wa-

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* *Vide* the diagram B, plate VI., upper line A.PP.

† *Vide* ground plan, Plate VI., PP—PP.

ter along, and to confine it effectually within their bounds, as with Necho's canal, would effect Ptolemy's purpose much better. So that the 20 M.P. of canal between Scenæ and Thoum, already referred to as part of the lxii. M.P. constituting, in Pliny's time, the length of the canal, and "the distance from the Nile to the sea," were only a restoration of part of the Etham branch, sacrificed by Necho upwards of three centuries before; and these 20 M.P. to Thoum or Patumos, + four, beyond that city, between it and the point of junction with Necho's canal, besides the excavations between the gulf-basin and Arsinoë, make up 35 of the 37½ assigned by Pliny as the total length of Ptolemy's canal operations. The residue of 2½ we shall find hereafter.

So perfect an agreement between nature and history cannot be purely accidental. We may feel warranted in assuming that, when Pliny wrote this account, the great gulf-basin was only *nominally* the sea; but that the real *open sea*, whose level coincided with the ocean, stopped at Arsinoë; that the "bitter springs," where Ptolemy ultimately suspended his operations, were some springs in that neighbourhood—(since all the wells about Suez and Ajrûd have that disagreeable quality);—and that the same reason deterred Ptolemy from cutting through the *second* barrier so lately interposed between the open sea and the former gulf, which had deterred Necho and his predecessors from cutting through the *first*. For it was a smaller inconvenience to go by land across a low sand bank that naturally and effectively kept out the sea, than to run the risk of an irruption, by attempting to make artificial dykes upon the tender sandy soil, too recently deserted by the sea to yield a safe foundation for such works as the terminal locks of a canal like this.*

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* Aristotle (Meteor. lib. i. c. xiv.) is the first authority who seems to contradict Herodotus, by speaking of the canal as not finished up to the sea, whereby he may have misled the succeeding Greek writers. For although Darius finished it, the subsequent removal of the head of the gulf would leave it as if it had not been finished. Thus the limit of this event is between the times of Darius and of Alexander.

Diodorus and Strabo, who wrote long after the reign of Ptolemy, add to this statement of Aristotle the works they attribute to Ptolemy, adducing, as the

Since it is now made clear that the large body of water to the south of the Serapeum was considered *the sea* in Pliny's time, it could not have been the "*bitter lakes*" that Strabo had mentioned 50 years before; and, indeed, he speaks of that very spot with more propriety of description than he has got credit for, "as the inner recess, *μυχος*, of the Arabian Gulf, the one close to Egypt," and on (or about) which, near Arsinoë, Heroopolis was situated, and other harbours and dwellings; near which were several canals with lakes adjacent to them, as well as the nome and city of Phagroriopolis; —a description which never could have applied exclusively to the immediate vicinity of the present gulf of Suez, from the want of fresh water which has always characterised that inhospitable region.

And if, even thus far, Strabo's own account would justify a doubt whether his "*bitter lakes*" occupied the place of the salt-marshes, that doubt will become a certainty, if we endeavour to apply the particulars he gives concerning the lakes, to this site that hitherto has been so unfortunately chosen to represent them.

Firstly, Strabo unequivocally refers to *several* lakes,† as those through which the canal that led to Arsinoë ran. Now,

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reason of the canals being unfinished, as they say, by *Darius*, the greater height of the Red Sea, which made him afraid of inundating the country by cutting through the isthmus; and they add that *Ptolemy*, who finished it, proved this to be an error; as, by means of an euripus,—a series of locks that were opened to admit the vessels, and closed again instantly,—the canal was made navigable to the sea without difficulty.

Diodorus, who is followed by Strabo, has evidently confounded the operations of Darius with those of Ptolemy. As the canal *was finished* up to the sea by Darius, according to the unequivocal account of Herodotus, the euripus would be wanted there, and that work should correctly be referred to Darius, its situation being at Baal-zephon or Port Daneon. But Diodorus was not aware of the sea's having retired, though he had learnt that, since Darius, some additions had been made to the canal by Ptolemy; the long established fact of its completion, and the ingenious structure of the euripus, which was a matter of equal notoriety, easily explain the confusion this writer makes between the authors of the two parts of the canal. Strabo has merely repeated his mistake. I have already shewn that, on this matter, he admits that he only spoke from report of those parts, which he had not visited.

† "διαῤῥεῖ δὲ καὶ διὰ τῶν πικρῶν καλουμένων λιμνῶν, αἳ πρότερον μὲν ἦσαν πικραί."

the large basin in question never can have formed more than *one lake* after its separation from the main. The form of the ground, in the section 1, places this point beyond dispute.

Secondly, So small a body of fresh water as any artificial canal, (even if it had run freely into the lake, which this particular canal did not), never could pour into it a sufficient quantity to sweeten the contents of such a basin of sea-water as this, full 20 miles long, averaging 5 in breadth, and 60 feet deep in the middle. The canal could only restore to its own level, whatever *water* the lake lost by evaporation. But as *salt does not evaporate*, the lake would always remain as salt as before, unless it had an outlet, by another canal, into a sea lower than either the canal or the lake; then, there being a current through it, the salt water might gradually be replaced by fresh.

Thirdly, But in the time of Strabo, no such canal existed. It went no farther than Arsinoë. Its final junction with the present Gulf of Suez, across the remainder of the newly formed barrier, was not effected till a century after Strabo wrote, by the Roman Emperors Trajan and Hadrian.* Although earlier authors than Pliny speak of the canal as being finished by Ptolemy Philadelphus, it is obvious that they only spoke from report, and confound the *first* termination of the canal with the *second;* the author of the one with that of the other;† but that the account given by Pliny is the true representation of the state of things *in his own time;* he takes up the matter where Herodotus broke off, and therefore, as the last contemporaneous authority, whose testimony has stood the ordeal of minute analysis, he is the most to be

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* Trajan's canal completed the restoration of the southern part of the Etham branch as a water-course. Beyond Scenæ to Heliopolis, it followed a deserted course of the Pelusiac, deflected from its former position to the present site of canal Abou-Menedgy, by the action of the same causes that have thrown the Canopic into the Sebennytic branch. From Heliopolis to Babylon, the rest of Trajan's canal, which is now the canal of Cairo, was an entirely artificial cutting,—its object, to raise the level of the water to that of the sea at Clysma, where it ended. Hence Claudius Ptolemy, the geographer (B. iv., c. 5.), says of it, that it flowed through Babylon and Heroopolis. (*Vide* Plate VI.)

† *Vide* Note to page 219.

credited. And the reason Pliny gives for Ptolemy's not attempting to cut his canal through the second barrier,—the greater height of the Red Sea,—is the very thing that would prevent the canal from flowing *through* the lake, had it been cut.

Fourthly, For, even if the junction were effected, the intervening canal could never possibly be made to convey water from the *lower* basin into the *higher* sea. The greatest precautions must, on the contrary, be taken to prevent the sea from pouring into the lower basin, *via* the canal, more salt water than it contained already; since the low basin would then replace what it had lost by evaporation, partly with salt water from one end, partly with fresh from the other, instead of doing so wholly with fresh as before. Thus, the tendency of such a junction, when effected, would rather be to increase the saltness of the lake, than to sweeten it.

Lastly, The large crystalline masses of salt,* found on the plains and marshes that now remain from this dried-up gulf basin, in such enormous quantities, that the Arabs of the desert have for centuries past made it a productive article of commerce, continue an unquestionable physical proof to this day, that would, in itself, suffice to certify—that the waters of that lake *have never been sweetened at all*.

There being so many conclusive reasons against assigning this position to the "so called Bitter Lakes" of Strabo;—the only hollows in the vicinity through which the canal could have flowed, are the Crocodile lakes,† through which the Etham river itself had flowed.

* Descr. de l'Eg., Journal, vol. xi., 323, 324. Mém. de Le Pére, ib. p. 122. Mém. De Dubois-Aymé, vol. xviii. p. 354; and of Devilliers, ib. p. 380, 381.

† This position has been assigned to the Bitter-lakes by M. Dubois-Aymé, and I regret not being able to coincide beyond this point with his hypothesis on the ancient geography of the district; neither as to the period when the open sea was cut off from the gulf-basin, nor as to the site of Pliny's "*Bitter fountains*." The former event he supposes may have been posterior even to the time of Hadrian. In that case, an open sea, accessible to the tides, must have extended to the Serapeum, in the time of Ptolemy; thus, any excavations on the shoal above Arsinoë would have been impossible, however shallow the water; and the 37½ M.P. of Ptolemy's canal operations must be found exclusive of this spot. This, M. Dubois-Aymé is obliged to do. He suggests that the

But if the river ran through them, *how could they have been bitter?* It is evident that the communication of the Nile must have been cut off, or they would always have been sweet, as when after this canal was introduced. That the river *did* flow through them has been physically proved. That Strabo's lakes could be situated nowhere else, will now, I hope, be readily granted. That the river, if cut off at all, must have been cut off before the time of Herodotus, is undeniable. That the construction of the land rendered such an operation expedient for the successful execution of the works of Darius, has also been demonstrated. And if, after the river was intercepted, and these lakes had remained insulated some time, the canal was re-introduced into them before the age of Strabo, and we can find vestiges of such works having been executed at the very time our theory requires,—then, I hope, the chain of circumstantial evidence will be as complete as can be desired, and far beyond what one could have anticipated, in an endeavour to elucidate a subject so obscure. For it is well known that the exudations of the soil throughout this region, in which the Nile no longer flows, have the property of imparting a disagreeable, bitter, and acrid quality to the water that collects in its hollows by filtration through the sandy soil. The wells now in the valley partake of it more or less; but the saline plains and marshes to the north of the Crocodile lake basin, are decidedly of that

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62 M.P. being the distance from the sea to the Nile, the canal of Ptolemy, beginning from the Nile near Bubastis, must have ended a little beyond Ras el Wady, where he, accordingly, places the "bitter fountains." Now, unless we entirely set aside the valuable contemporaneous testimony of Herodotus, who not only has described, with a degree of circumstantial precision, which a glance at the map (Plate VI.), will enable us duly to appreciate, the very place where the canal was begun by Necho, and its entire course as completed by Darius to the Arabian Gulf, into which it was discharged; the hypothesis of M. Dubois-Aymé will amount to this,—that Ptolemy dug 37 miles of a canal, along a valley where a canal had existed for 330 years;—that he left off for fear of the greater height of the sea, at a place that the sea had never come to within 20 miles of; —and that he then and there, and on that account, left unfinished, a work that *was finished up to the sea* 200 years before he was born. *Vide* Descr. de l'Eg., Et Mod., vol. xi., and App., vol. xviii. Mém. of Dubois-Aymé, "Sur les anciennes limites de la Mer Rouge."

that character. Therefore the lakes themselves, if insulated, would not remain exempt from a quality that resides in the very soil they lie upon.

Here, then, is the topographical proof that such a succession of operations were executed, in the locality mentioned, and during the interval we require. We must follow M. Lepère along the traces of the ancient canal. Having passed the spot east of Hero, where he remarked that "no *canal* seemed ever to have existed," since he found no dikes,—and where we now understand why none ever could be required—because there had existed a natural stream, flowing rapidly downwards between high banks, through the opening of the hills, (*vide* Plate VI., N to S.), he now leaves the point where the waters of 1800 bent off northwards into the lakes; and he continues his search along the remains of the *artificial* channel that branched out of the true river at this point, in a somewhat SW. direction, begun, as some ancient authors assert, by "Sesostris," and continued by Darius to the sea (*vide* Plate VI., S, S, D). When he came to the place where the canal of Darius may have begun (S), he remarked the reappearance of dykes. "Dans cette partie, la vallée est plus ouverte; le côté nord est remarquable par un abaissement du sol, et une végétation très abondante, qui a l'aspect d'un bois taillis." (This is the large circular basin enclosing the Crocodile lakes.) "On retrouve encore dans cette partie la dérivation d'un canal dirigée au nord sur un monticule de décombres qui a dû être le site d'une ancienne ville." This site coincides in position with the Thaubasio of the "Itinerary," viii. M. P., from the Serapeum.* The mound is an eminence in the middle of the valley enclosing the lakes. "Une des digues se prolonge à l'est, et semble séparer le bassin des lacs d'une plaine basse et saline qui se dirige au nord vers le Ras-el-Moyeh."†

These are precisely the indications we required. As this

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* *i. e.* V M. P. along the sea-canal, across the opening of Hero, and iii., along the little branch canal above described.

† Mém. sur le canal des deux mers. Descr. de l'Egypte, Et. Mod., vol. xi. p. 120, 121.

short branch canal, leading through the lakes, begins about two miles beyond the ancient river's point of natural entrance into them, the very fact of an artificial communication having been opened, presupposes that the natural entrance must have been closed up at a former period; otherwise, another entrance had neither been wanted nor made.

The remains of a large embankment across the north-eastern opening of the low basin enclosing the lakes, and separating it from the still lower saline plains to the north,* reveal with equal clearness the fact, that there the waters were confined by art within that basin, at the place where originally, the river flowed out of them. It appears then demonstrated by these remains, that although the water of the river, after having been excluded from the lakes at one point,† was re-admitted into them at another, by means of this little branch canal,‡ it was not allowed to go beyond the basin; shewing that the same purpose had been kept in view in both operations—of keeping up the level of the water in the canal by *stopping out the final course of the river*, only *from a different spot.*

The succession of events, and the periods to which they are referable, no longer admit of a doubt. When the purpose of Darius required that the only outlet of the waters should be the Arabian Gulf, let us suppose he merely cut off their farther progress downwards in a contrary direction, at the place where the stoppage would be most easily effected. This brings us up to the age of Herodotus—and the Etham branch of the Nile has ceased to exist. The lakes, being now so far separated from the channel of the Nile, as to be fed only by the filtration of its waters through the sandy soil of that district, would then become "*bitter lakes*"—their waters of inferior quality for drinking, although still answering the purpose of irrigating and fertilizing the beautiful valley that enclosed them in its bosom.

Another monarch (which can only have been Ptolemy Philadelphus, whose extensive operations relative to the canal, so variously recorded, preceded the era of Strabo by three

* *Vide* Plate VI. † *Vide* S. Plate VI. ‡ *Vide* PP. ibid.

centuries), may have thought of turning those lakes to better account, by converting them into a reservoir during the inundation, to supply the canal when the Nile was low—a project by no means of difficult execution, from the advantageous position of the lakes; since it was only necessary to re-open a communication with them, and to transfer the stoppage of the river's course from its place of entrance to its point of exit. The first was effected by the little branch canal—the latter by the great transverse embankment. This brings us up to the time of Strabo, and he might then well say of these lakes, that "formerly they were bitter;" but "had been made sweet by the canal that flowed through them."

And, in conclusion, the little canal between 2 and 3 M. P. long, would just make up the complement of the 37½ of works attributed to Ptolemy Philadelphus by Pliny's account.

This last circumstance is the only direct indication from which the supposed operations about the "*bitter lakes*" may be referred personally to Ptolemy, as part of a connected series of works, all essential to the success of his canal enterprise; but where *direct* proof, in the satisfactory form of an authentic historical statement, is wanting, we must be content with a reasonable degree of indirect evidence. The vestiges of these operations, by themselves, prove nothing; but considered in connexion with Strabo's account concerning these lakes, they unquestionably indicate that after the Nile had been excluded from them, before the time of Herodotus, it was re-admitted into them by means of a canal, before Strabo wrote; and even though we had no further clue to the authors of these works, the main object of this inquiry would be proved, namely, that the Etham arm of the Nile was cut off from its course at a particular time, and at a particular spot. Whether this was done by Darius and Ptolemy themselves, or by their immediate predecessors or successors, is quite a secondary question; its solution may be a matter of curious interest, but is not indispensable to establish the point at issue, which is, the former existence and intentional suppression of this river. But when, upon a critical analysis of the levels of land and water, we find that all the works connected with this suppression were indispensable to the success of the canal enterprise of Darius and Ptolemy, it would be a very unusual coincidence of error to find such distinct evidences of the time and place of this operation, combined with such proofs of its necessity as the structure of the land displays, if, after all, these monarchs had not executed the works this theory attributes to them.

Since the partial restoration of the river under Ptolemy and Trajan, it has always been regarded as a canal—a *work of art*—a decayed monument of national enterprise, illustrating the triumph of human perseverance over the most formidable natural difficulties, and whose origin is lost in the gloom of fabulous antiquity. After the canal fell into ruins from disuse and neglect, the summary process of turning the course of the waters another way, by the dykes of Tel el Jehud,* was resorted to; and the manner in which the river remains suppressed to this day, so effectually, that its former existence is not even suspected, is thus too obvious to require further explanation. The flood of 1800 threw the valley out of cultivation for two years. No wonder, then, that it should be more expedient to keep the water low by means of dykes, and to exclude it altogether from the valley, than to let it take its natural course. To restore the entire canal, so that the waters could be conducted safely through it, as in ancient times, is a work which the recent condition of Egyptian affairs has offered as yet no motive for attempting. Mohammed Ali has replaced a piece of Necho's canal, up to near Abbasieh, but only for irrigation. The supply of water can never surpass the low level to which the canal Abou-Menedgy, from which it is drawn, is itself artificially kept down near Shibbeen ; unless, by design or accident, the dykes that confine its waters should be removed, and present again the unexpected, but perfectly natural, phenomena of 1800, by which so startling and convincing a proof was afforded to confirm my conclusion, that an arm of the Nile, which, in the remotest ages of historical antiquity, was the natural frontier fortification of Arabian Egypt, has been sacrificed to the exigencies of man ; that it has been removed out of its

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* *Vide ante*, p. 38, and Plate V., section 2.

course, partly or wholly, on repeated occasions and in various ways, to minister to his purposes; and that, to this day, it continues to be held in abeyance, but is not naturally extinct.

CONCLUSION.

A very few additional remarks will suffice to indicate the application of the results brought to light by this geographical inquiry to the illustration of Ancient, and especially of Sacred History. In an extensive tract now uninhabitable, never visited by travellers, consisting partly of unhealthy marshes, partly of a barren sandy waste, and entirely destitute of running water, we discover what was, 3500 years ago, a land endowed with a variety of natural advantages both for commerce and defence, of peculiar importance to a frontier state, and seldom found united in a district of such limited extent. While the river that formed its eastern limit, and flowed to within six miles of the Red Sea, was the axis of its prosperity, by connecting a line of fortified frontier cities, situated in the most commanding positions, and whose beginning is lost in the remotest antiquity. The abundant ruins scattered over the Egyptian "Arabia," as well as the historical records of works carried on along its boundary line, remain unquestionable tokens that its natural capabilities were duly appreciated by the lords of the land; and that these were snfficient to bear out the fragmentary intimations handed down by historical tradition, concerning the power once acquired by its earliest colonists, the "Hyk-sos," or royal Shepherd tribes, whose encroachments on their neighbours' territories it required the united efforts of the king of Thebes and all the rest of the Egyptians to subdue; and when this coalition had compelled them to yield their ground, we are at no loss to understand the motive of the Egyptian monarch's policy (Exod. i. 9, 10). The Egyptians saw another people of similar simple and pastoral habits, increasing rapidly in the country from which the ancient rivals of their power had been expelled with so much difficulty, and who, from their position, even more than from their numbers, might become dangerous neighbours, should they increase sufficiently to assert their independence. Such a national calamity the kings of Egypt hoped to avert by the summary expedient recorded in the opening chapters of Exodus.

And when, after the long course of oppression systematically practised against the children of Israel, in pursuance of this barbarous policy, these were finally delivered by the manifest interference of the Divine Power, we need no longer wonder how so vast a body—including the mixed multitude that shared their fortunes—were sustained on the way, as they went out of the land of Egypt " with a high hand ;" since that way is no longer the doubtful and improbable track hitherto assigned to them, in defiance of possibility and geography, through stations marked out at random, at impracticable distances from each other, across the heart of a desert without water or vegetation. The ingenious identification of some of these stations, suggested by Mr Sharpe, being so well borne out by all that the minutest inquiry can elicit respecting the former condition of the country as to amount to a complete demonstration, satisfies us that their track was an orderly progress along that line of ancient frontier-cities about which their own tent-villages were clustered, and our conception of this important passage of sacred history is invested with a clearness and certainty it never possessed before. We can now appreciate, as it deserves, the circumstantial fidelity of the Mosaic narrative, in agreeing with every peculiarity of position which the primeval geography of the land, now rescued from the gloom and oblivion of ages, reveals. The road followed by this great multitude turns out to have been the same kind of road as all ancient and modern Egyptian roads, the *banks of a river* or canal. The spots where they encamped were near cities, the remains of which still exist, all at an easy day's journey from one another ;—the object of their progress, the very natural one of gathering together the residue of their numbers that might yet be scattered through the villages near these cities, prior to their final evacuation of the country.

Having started from { Rameses,* Heliopolis, } and passed through

* Exod. xii. 37.

{ Succoth / Scenæ } and { Etham or Pithom,[*] / Thoum or Patumos, } where, after skirting the neighbourhood of { Hiroth, / Heroopolis, } they turned out of the second and only remaining frontier route, and re-entered the wilderness,[†] to encamp in face of the heights of { Baal-zephon, / Port Daneon and Serapeum, } by the sea; we shall perceive by the map,[‡] that, if they left this, their last encampment, in the morning, just as the host of Pharaoh appeared in sight, an easy day's journey would bring them to a spot which satisfies all the conditions required by the Mosaic narrative of the passage of the Red Sea.[§] This spot is exactly opposite the unidentified ruins where the Persepolitan remains were seen; at the northern end of the great shoal, separating the upper gulf-basin from the present Gulf of Suez, and about 12 geographical miles, or a day's journey, from the site to which, hitherto, the passage of the Israelites has most generally been referred. The strait, there, can hardly have been more than two miles wide, which would admit of the whole army crossing over "before the morning watch," "when the sea returned to its strength." The pass is even now 10 feet below the level of the Red Sea. It may not have gained materially in height since this memorable event; as the southern end of the shoal was the one most exposed to the effects of the accumulations, which finally cut off the sea from the gulf-basin. In the time of Moses, the sea there must have been much too deep to be fordable under *any ordinary circumstances*. But on this one momentous occasion, when the effects of a supernatural strong wind[‖] were permitted, by the manifest interposition of Divine Providence, to combine with the excessive tides of the equinoctial season, the entire strait must have been laid dry under so unsual and unexpected a combination of circumstances, which it required a miraculous special interference to produce, and a no less miraculous special guidance to be, like Moses, prepared for.

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* Exod. xiii. 20. † Ib. xiv. 1–9. ‡ *Vide*, Plate IV.
§ *Vide*, Section 1 Plate V. ‖ Exod. xiv. 21-27.

It may not be unworthy of a passing notice to add, in conclusion, that by comparing the present state of the Egyptian frontier district with its primitive condition, as deduced from the numerous historical and topographical details upon which this inquiry is founded, we obtain a natural explanation of a very remarkable passage in Isaiah, intended as a prophetic intimation of the desolate state in which the land, once so familiar to the Hebrews, was destined to remain during the latter days preceding the final restoration.

"And it shall come to pass in that day, that the Lord will again set his hand a second time to recover the remnant of his people. * * * And the Lord will utterly destroy (or dry up) the tongue of the Egyptian Sea, and with his mighty wind He will wave his hand over the river, and smite it in the seven streams, so that one may walk over *in sandals;* and there shall be an highway for the remnant of his people, that are left of Assyria, as there was to Israel in the day that he ascended out of Egypt."—(Isaiah, ch. xi., ver. 11–15.)

Sir Gardner Wilkinson* has already suggested the possible application of the last clause in ver. 15, to the present physical condition of the river of Egypt. May not its beginning be deemed an equally significant allusion to the future condition of her sea, under the same stage of the great providential dispensation? If it has really come to pass, that all the natural mouths of the Nile are so reduced as to be, literally, crossed over "in sandals;" the only channels remaining navigable all the year round being the two which Herodotus says were the work of art; it is equally true that, since the days of Isaiah, "the tongue of the Egyptian Sea" has ceased to exist. For whether we read, as in the present state of the Hebrew text, החרים,† incorrectly translated,

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* Modern Egypt and Thebes, vol. i.

† Gesenius follows the present text, and takes it in the sense of a threat or imprecation. This is not far from the radical sense of the word; which is to *devote, excommunicate, anathemize,* a sentence which, in some cases, did involve he destruction of whatever had been so devoted; but the word does not *in itself* mean "to destroy," and, therefore, does not seem a fit expression to apply to a ea in the present case. The slight difference in the formation of the final letter, which would alter its signification to "dry up," is supported by the Chaldee version that has יבש *dry up*. The Septuagint translators also must have read החריב, since they render this word in the passage in question

"utterly destroy;" or whether we adopt the more critically correct expression, as restored by the learned Bishop Lowth, החריב rendered, in his beautiful translation, "smite with a drought"—the fact is before us—in an arm of the sea 35 miles long, changed into a waste of sand and saline marsh, and remaining, to this day, a speaking and instructive instance of the literally accomplished doom, pronounced on the land by the inspired voice of Prophecy, in the days of her glory and pride.

The Bubis, or Edeeyah of Fernando Po. By THOMAS R. HEYWOOD THOMSON, M.D. Communicated to the Edinburgh New Philosophical Journal by the Ethnological Society of London.*

Of the different localities in Western Africa, visited by the Niger Expedition in 1841 and 1842, perhaps no one presented a greater number of new and interesting features to the inquirer than the island of Fernando Po, in the Bight of Biafra. Lying between 3° 12′ and 3° 67′, north latitude, and 8° 46′ and 8° 57′ east longitude, it forms, towards the southern extremity, an oblong square, about 35 miles in length, and 22 in breadth. The land is high, and in many parts precipitous. Two principal mountain ranges intersect the island in a northeast direction, of which Clarence Peak, rising to a height of

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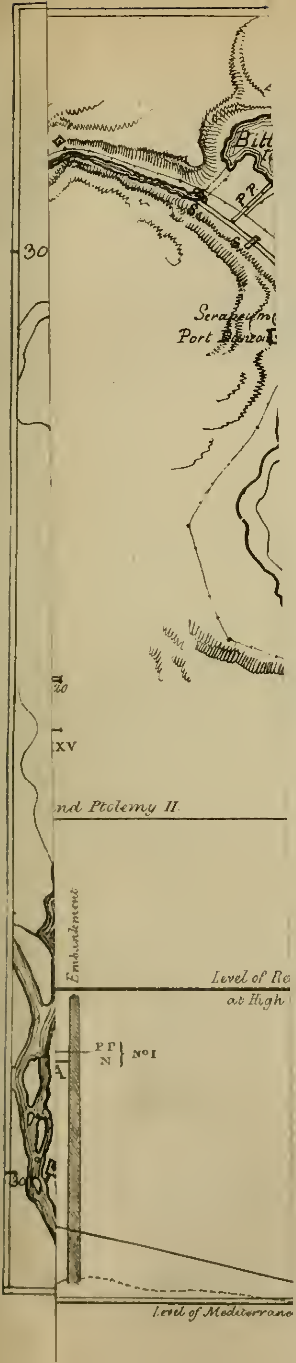
by ερηωσει, "make dry, barren, or desolate," as in all other passages which it occurs; moreover the expression "drying up the sea" is frequent in prophetic poetry, whether intended to be taken figuratively or literally.

This conformity between the two most ancient versions leaves scarcely a doubt that the original reading was, "And JEHOVAH will *dry up* the tongue of the Egyptian Sea." Although the separation of the gulf-basin dates from the last century of the Persian domination in Egypt, and upwards of three centuries after Isaiah wrote the above, "*the tongue of the Egyptian Sea*" was not "*dried up*" until the power of Egypt had reached its lowest stage of decadence under the Moslem rule, when the canal was left to fall into ruins, and its waters were turned off another way.

And that very shoal, which *once* was made "*an highway for Israel, when he ascended out of Egypt*," has become a permanent highway for the people. The Mecca pilgrims' caravan route from Cairo, through the desert, crosses it a little north of Arsinoë.

* Read before the Ethnological Society of London, 8th Dec. 1847.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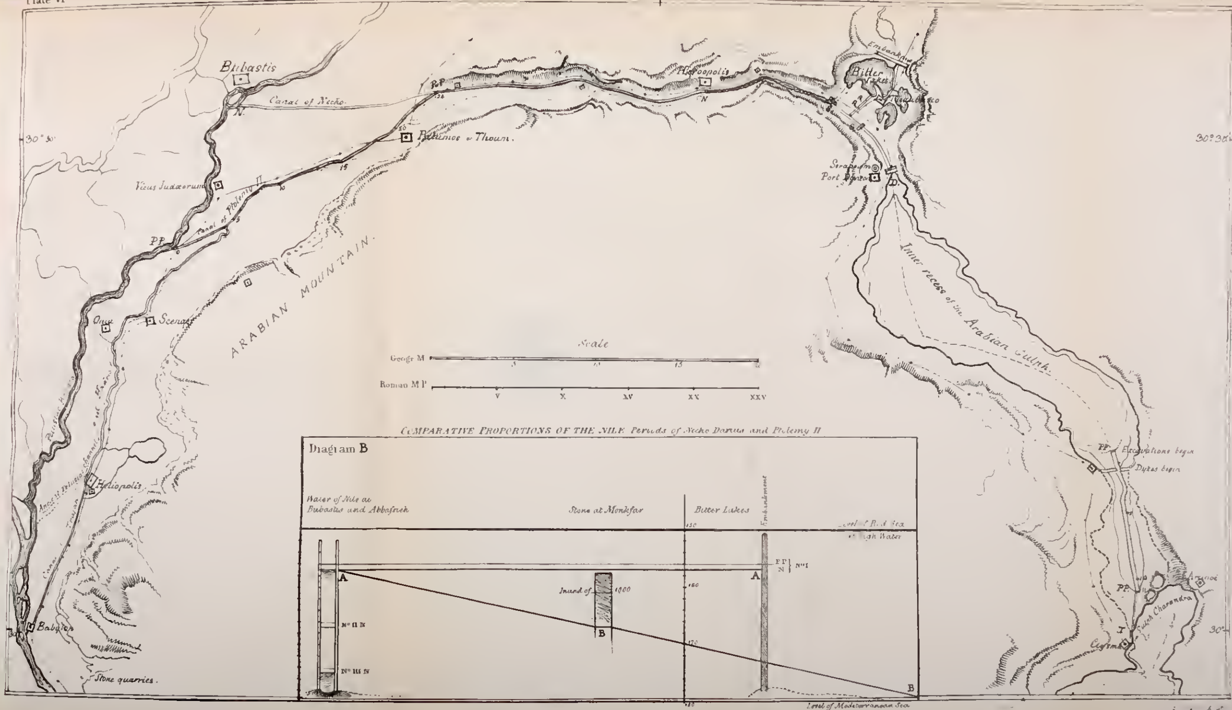

GROUND PLAN OF THE ANCIENT SEA CANAL

11,000 feet, forms the leading feature; while a less elevated range, at the southern end, separates Melville Bay and Cape Badgely. The appearance of the island is picturesque in the extreme, being well wooded, even towards the higher ranges; while, skirting the sea, may be observed numerous varieties of high and umbrageous trees, among which the graceful palm and the towering bombax, or cotton tree, stand forth conspicuous. At most of the little ravines, a stream of good clear water is found; but in no part of the island could be discovered any marsh or alluvial deposites. The rainy season lasts from May to December, when it is followed by the "smokes," a peculiar dense vapour which envelopes the island, and extends for some distance to seaward.

The object of the present paper is to bring under consideration the physical and moral condition of the "Edeeyah." It is unnecessary, therefore, to dwell at greater length on the characteristics of the island; suffice it to say, that whether we examine its animal, its vegetable, or mineral productions, novelty is written on all. Little notice has, however, been taken of this small portion of Western Africa, although it is only 20 miles from the mainland of Cameroons, and many of the vegetables, and nearly all the animals, are peculiar to itself; while the natives offer, in their language, customs, and even in their physical appearance, such distinctions to their continental neighbours, as fairly entitle them to be placed by themselves.

It may be proper to state, that the nature of the country is so mountainous, and covered with such impenetrable forests, that the natives of its opposite sides are almost unknown to each other, which rendered it impossible for me, with my limited means, to visit in person all the native towns to be mentioned; but the information on each was received, with due precaution, from creditable and competent persons, who, in trading speculations, had passed some time among them.

Altogether there are about fifteen native towns and villages situated at different points of the island, and in some of them the dialects spoken are so peculiar and distinct as to be quite unintelligible to their neighbours.

Thus at Bănňa-pă, Băssă-pōo, Bāssī-lĭ. Rēbōl-lă, Băriŏ-bātăh, Bāssă-pŭ, Bū-ŏtonos, Tūpŭllö-pūllă, the language or dialect spoken is that given in the accompanying vocabulary, under the head of Edĕēyăh. At West Bay, Bī-ĭllĭ-pă, Bario-bĭ, there is another quite as distinct, while at another native town, name unknown, on the south-east side, another obtains; and in bartering with the Būbĭs, who go round from the neighbourhood of Clarence to purchase the earthen pots and jars made there, the traffic is carried on by signs. We saw several during our sojourn at Clarence Cove, who could not make themselves intelligible to the Edeeyahs.

Thus, it is evident there are two or more dialects, if not distinct languages, in this small island; and it is to be regretted that the opportunity did not occur to procure vocabularies, as no doubt a comparison would have removed any questions as to their common origin, which we are inclined to believe, from the general resemblance of their physical characters.

The Edeeyah have mostly been spoken of, by such persons as have seen them, under the name of Būbĭs, from their usual salutation on meeting a stranger—of Būbĭ, the Edeeyah term for friend. They are for the most part well made and muscular, with an average height of 5 feet 6$\frac{1}{6}$ inches, as deduced from the measurement of fifteen men taken indiscriminately as they passed through Clarence; round the chest 37$\frac{1}{2}$ inches, and from trochanter major to the sole of the foot 32$\frac{3}{8}$ inches; across the head, from one meatus auditorius extreme to the other, 13$\frac{6}{8}$ inches; from occipital protuberance to nasal process 32$\frac{1}{2}$ inches. Facial angle, 72. The face is more inclined to be round, the cheek-bones not so high, the nose less expanded, the lips thinner, and the mouth better formed than in most other Africans. The eye is at once expressive of intelligence and good-humour. The hair is softer and longer than in any of the West Africans, and although there is a tendency to curl, it is not crispy as in the other Negroes. The skin is not so black; it is more of an olive shade, and is soft and unctuous.

The lower extremities are particularly powerful, and the muscles strongly developed; and from this probably arises the appearance as if the body was unnaturally long, and the legs, from the pelvis downward, shortened.

The continual exercise on foot, as well as the habit of sitting with the legs doubled up to the chin, must tend to produce this unusual development of the lower extremities, which is so striking a feature that the most careless observer can scarcely fail to notice it. The hands and feet are, for the most part, smaller than in other Africans. In many of the females they are beautifully proportional; and, indeed, the general symmetry of some Edeeyah girls at Bassapoo was perfect. The women have generally a soft and rather pleasing expression of countenance, which even the horrid practice of cutting strong lines across the face does not remove. This is usually done when young; and in both sexes, to come up to the Bubi idea of beauty, the marks on cicatrisation should be raised and corrugated. It must be, indeed, a painful operation; but, like civilised nations, much must be sacrificed to the prevailing taste or fashion. Palm oil is much used about their persons, mixed either with clay or ferruginous earth, with which they daub themselves in various ways, so as to produce a savage and wild appearance, quite inconsistent with their gentle and harmless disposition.

They have several modes of arranging the hair, which is done up into a greater or less number of knobs, with red clay, and with which they sometimes unite small bones of the dogs or monkeys. In some, the hair is made up into one large mass with red clay, weighing many pounds, which one would suppose to be a painful sacrifice to fashion; but the simple Edeeyah prides himself on his coiffure, and willingly submits to what will enhance his appearance.

No tribe of Africans have such antipathy to European clothing as this singular people. Notwithstanding the frequent intercourse many of them have had with our settlement at Clarence, no article of dress has been adopted. The little bunch of grass suspended between the thighs, and the flat or conical grass hat, are the only attempts at covering they have ventured on. Their ornaments consist of little chains of grass, neatly woven, the vertebræ of snakes, monkeys, and dogs, and, in the richer persons, a lump of suet, inclosed in a portion of intestine, and suspended round the neck, is a choice ornament, as well as a supposed charm. Country money, a small species of limpit, made round, and strung in long lines, is also a favourite addition, fastened round the arms and legs; so that one can judge of the wealth of many of them by the quantity of this ornament. Among the chiefs, the head and horns of a goat, or of the golden rood-bocke, is secured to the hat. Nearly all have little grass bracelets and armlets, in which they secure the knife, a most useful article, and almost the only European one they care for.

The first impression conveyed to the observer on seeing an Adeeyah in his native woods, is certainly anything but favourable. The face cut and disfigured by transverse stripes; the hair done up with red knobs; the body painted, or rather bedaubed, into red and yellow clay; a bunch of grass to cover those portions of the person which even savages are averse to display; a little flat grass hat, fastened to the head by a skewer; the long wooden spear raised on high as if to be brought into immediate use, seldom fail to produce the conclusion that here is the very acme of barbarous and savage life. A little inquiry, however, into the native character and the laws by which they are regulated removes the prejudice, and we feel deeply interested in a race presenting such an anomalous combination of the wisest and most civilised laws, with the rudest and most untutored state of nature. On the testimony of George Ireland, a liberated African, and a very intelligent person, who lived among the Edeeyah for eleven years, and had visited most parts of the island, they are described as being most hospitable and generous to strangers, humane, and kindly-disposed towards each other in their several communities, both in health and sickness, willing to assist each other in difficulties, brave, yet forbearing, and reluctant to spill the blood even of their enemies; and these good traits we can vouch for, not only on general authority, but from our own observations among them.

Their battles are not attended with cruelties; their religious rites untainted by human blood,—in this affording a notable difference between them and most Africans, who make their fellow-creatures the grand victims for conciliating the *jūjūs*, or fetishes. Murder is unknown among them; so much so, that a chief near Clarence received the cognomen of Cut-throat, for an attempt made on the life of one of his subjects, whom he discovered in the act of stealing from a vessel of war's boat, during Captain Owen's visit in 1825. They are remarkably honest. We have seen them exposed to such temptations as few Africans can resist, and yet not betray the confidence placed in them.

In Lieutenant Botelar's narrative of the survey under Captain Owen, in H.M.S. Leven and Banacouta, he says,—" Our intercourse with savages of various tribes and nations, for the last four years, has far exceeded that which generally falls to the lot of navigators or travellers overland, yet never did we meet with a people more savage in appearance, or more singular in their customs, than the people of Fernando Po. In stature, they were generally low, yet of perfectly symmetrical form, and, in many cases, of Herculean mould. In hue they varied much, some being black, and others of a copper colour. Their features were all of exactly the same cast, so that I cannot imagine the latter had sprung from intercourse with the white."—" Their features were pregnant with intelligence." Again, he says,—" In no place that we visited did the natives appear to be in a state of such barbarism as at Fernando Po; yet they manifested the greatest horror of theft, which would have done credit to people more advanced in civilisation;" and " they made signs that the person who had committed the theft should atone for it by the loss of one or both hands."

Botelar also says, p. 464,—" The further insight into the character of the Fernando Po people, gained on our second visit to the island, tended to shew that, however barbarous they appear to strangers, yet among themselves they have very salutary regulations, not less apparent in their civil government than in a military point of view."

Neither foreign nor domestic slavery is tolerated; indeed, a spirit of independence is discernible in their very bearing and look. The Spanish colonists were driven from the island during the end of the seventeenth century, for endeavouring to carry on the slave-trade, and to entrap the inhabitants. Each town and village has its king or chief, who with the head men and jūjū men, or Buyeh-rūpīs, settle all disputes. The only acknowledgment made to the more powerful chiefs is that respect which their superior power ensures. They have no traditionary account of their origin or settlement on the island.

The religion of these strange people is paganism; while at the same time they believe in and worship as the great head of their religion, an unknown great spirit whom they call Rūpī, and whom they believe to be the sovereign ruler of the world. The idols (different wooden and earthen figures) are called "Mōhs," while the priests or Jūjū men, of which there are always two to each village and town, are styled Buyeh-Rūpīs. It is needless to say that these latter possess unlimited confidence and control, and are in fact the principal movers in all unusual events, since nothing can be commenced or carried on without consulting the "Mōhs" or idols, a prerogative only granted to the Buyeh-Rūpīs. The offerings to the mohs or idols are portions of cooked meat, venison, ground pig, fowl, and palm wine or tōpĭ. Like most Africans, the Edeeyah always spits out the first mouthful of spirits, or any beverage he is about to partake of, as a portion for the Moh! or god. The principal religious festival is just before planting the yam, and not at the completion of the harvest as in other parts of Africa. At the season just spoken of, they make up a large hunting party in each village or town, for the capture of a sort of buffalo which is said to be found in the mountains. It resembles a bullock, but is larger; it is black above, with some white about the belly. It is wild, scarce, and difficult to be procured, also for the golden roode-bocke and philatumba (two species of antelope), monkeys, a species of large rat, called a ground pig, for the purpose of making a great peace-offering to the unknown god Rūpĭ, through the mediation of the mohs or idols. The meat is roasted and placed before them; after which the tribe partake of the remainder, eating almost to a surfeit. They believe by this feast the deities are conciliated, and a good yam season insured. Tōpi, or palm wine, is freely partaken of on such occasions, and is then kept prepared in its most exhilarating form.

On the decease of any member of a tribe, lamentation is made for seven suns or days. The body is covered with a sort of white clay, and buried the day of decease. A hole is dug just large enough to receive the body placed on its side in a sitting posture, with the legs doubled up, and the head laid toward the Peak of Clarence, the highest mountain point. Whether this may have any connexion with the belief entertained by many of them, that the rupi visits the peak occasionally (when, they say, fire is seen), it is difficult to ascertain.

The whole term of mourning, or remembrance of the departed, is one month, or twenty-eight suns or days, during which the relatives assemble in one place, where they eat together, and drink the fermented topi or palm wine. Thus, though held to be a period of mourning, it is rather one of great rejoicing. At the end of the month, four of the sons —if the deceased has that number, or, if unmarried, four relatives—are obliged to go out hunting to procure the favourite food of the Edeeyah, the bush pig, which, when cooked in a small earthen vessel, is partaken of by those only who were engaged in the hunt; after which, some of it, with yam and palm-oil and topi, are placed on the grave for the supposed use of the dead. To touch the foot of a deceased person is considered a most unfortunate and distressing circumstance, and almost certain to be followed by the death or some sad calamity of the party, and that very immediately. Their rude ornaments are buried with them. The money (a small species of patella), as also the yams or other property, are divided equally among all the children, if he has any; if not, among the other relatives.

Like the Jews, and some other eastern nations, the Edeeyahs have a system of betrothal, which must continue for two years before sexual connection is permitted, during which time, the aspirant to the fair possession is obliged to perform all the labour which would otherwise fall on his intended wife, viz., planting yams, carrying water, palm-oil, &c. This is only observed in the case of the first wife. The courtship or betrothal commences generally at thirteen or fourteen years of age, but connection is not permitted until the conclusion of the two years; and should frail nature yield before the specified time, the offence is treated as *seduction*, and the youth severely punished, as well as exacting heavy fines from the offender's relatives. Indeed, to seduce an Edeeyah girl is one of the most serious offences; and they sometimes even destroy the dwelling of the relatives, as well as seizing their yams and other property. After the term of betrothal, the female is obliged to remain in the hut, from which she is not allowed to wander out until there are unequivocal signs of pregnancy. If this does not take place, she continues under observation in her hut for eighteen months or moons. On her first appearance, or joining the tribe as a married woman, a feast is held by the friends. Polygamy is universally permitted, the number of wives depending much on the circumstances of the party. Two and three are the usual number; but some of the chiefs have large harems, a few upwards of 100. Būllōkā, king of Bāriŏ-bàtăh, a town seven miles from Clarence, is said to have upwards of 200: how far correct, I know not. Still it appears that females are much more numerous than males; which the natives admit to be the case.

Adultery is considered a very aggravated crime against their social system. For the first offence both parties are punished by the loss of a hand; but in the case of the man, he can only lose one: the punishment for the second offence being severe chastisement and heavy fines, extended even to the property of the relatives. The woman loses her remaining hand for a repetition of the adultery; a third offence disqualifies for a continuance in the village or town. These unfortunate women mostly take refuge with the Kroomen. I noticed several who had forfeited both hands, living in the care of the Kroomen at Clarence. Adultery is said to be very unfrequent. The amputation is performed with a common knife, and is done at the wrist-joint. After the operation, a vegetable stringent is applied, which is said to control the hæmorrhage. Clay is put over all, and the arm held upright by a relay of friends. The body is covered with clay and palm-oil, to keep the sufferer as warm as possible. I examined the stumps of several of these unhappy offenders against the Adeeyah system of morals, and they looked as well as if done by the most accomplished surgeon. Death seldom results from the operation. Of the number of inhabitants collectively, or in the respective towns and villages, it would be hazardous to surmise, since no authentic information can be procured on the subject. Some have stated 5000 to be the probable estimate; but, judging from the well-known harems of some of its chiefs, as also the population of some of the smaller towns near Clarence, I should say 15,000, not to exceed. Bāssā-pōo and Bān-nă-pā, though small towns, would seem to have not less than 1000 to 1200 each, from what we noticed on visiting them.

The dwellings of the Edeeyahs are most primitive and uncomfortable. At many of the villages and towns we visited, the greater number of the huts were formed simply by spreading a coarse matting of palm-leaves over four rude posts, just large enough to screen the tenants from the dew and part of the rain, but open to all the winds of heaven. The more wealthy have, however, their domiciles of wicker-work of a square form, and even plastered with mud. Such obtain in the villages and towns near Clarence chiefly, and have probably been imitated from those of our Sierra Leone settlers there. A pillow, hewn out of a block of palm-tree, an earthenware pot to boil yams, a pipe for smoking, and a topi calabash, make up the list of their furniture.

When we remember the variable nature of the climate, and its heavy rains from May to December, it is truly surprising how anything human could exist under such circumstances; and yet they are not only robust, but enjoy good health; and except smallpox, from which they suffer dreadfully when once introduced, they have few disorders of a rapid or serious character. The principal diseases are light fevers, and skin affections; psora, in its worst and African form; and some cases of dracunculus, or guinea-worm; but now and then a case of elephantiasis of the lower extremity is seen. I need not mention that, once that scourge of mankind (especially the black portion), the smallpox, commences, it spreads with rapidity through the tribe, and carries off great numbers. As yet, little has been done to introduce the vaccine among them, as their Buyeh-rūpis or priests are the doctors, and they regard with distrust and ill-feeling anything which is likely to remove or weaken their influence among the tribes. They use a few vegetable remedies; and anointing certain parts of the body with clay and palm-oil near a fire, is a common means for headaches and skin diseases; but the chief reliance is placed in the propitiatory powers of the priest to invoke the mohs or idols; and if the sick person dies, it is only considered to be the operation of the gods, who did not wish him to be retained any longer in the tribe. We omitted to state in the proper place, that the females have a fair portion of labour assigned to them, such as planting and collecting the yam, preparing and carrying the palm-oil to the traders, &c.; but they are certainly treated with greater consideration and kindness than in any part of Africa we visited, and they appear to be much attached to their husbands and children.

The Edeeyahs are expert hunts; they use the spear and sling with great precision, and kill squirrels, lizards, and birds this way. When a tribe is engaged in a hunt, the sight is novel and exciting in the extreme. On one occasion, we had a party of 200 natives from Bānnāpa, who came, agreeably to their promise, to let the White man see "Bubi hunt." They first secured a number of nets, very strongly made of bark, to the surrounding trees; after which, the juju man, or Buyeh-rupi, began to vociferate loudly, using the most absurd gesticulations, in which he was occasionally followed by the others. Their strangely painted bodies, the almost unity of voice with which the party responded to the Buyeh-rupi, as well as the frantic manner in which they threw their arms about from time to time, formed a scene of the strangest interest; nor was it the less so, as being enacted under the waving palm, and lofty bombax or cotton-trees. After waiting about half an hour, by which time the juju man had got the mohs into a favourable humour, at a given signal each person rushed to a small tree, from which he plucked some leaves, and commenced rubbing them briskly between the hands; some were put into the grass armlets. The chief also placed some in the button-holes of our shooting-coats. On inquiry, we found it was intended as a token of good feeling among all pres ent; that if any should be killed or wounded in the hunt, it was not to be considered as intentional, but the result of accident. The whole party then separated into two long lines, and commenced beating the bushes to drive the deer and game down to the nets. Such of us as had guns were placed at the spots they expected the golden roode-bocke, or larger deer, to break through.

Unfortunately a tornado came on, and the party was obliged to break up without having secured much game.

The Edeeyah mode of dancing is both strange and uncouth. On festive occasions they fasten dry palm-leaves, &c. all over their persons ;—these, tossed about in their frantic evolutions, cause a rustling noise, which, with a sort of pavior's grunt, eh! eh! eh! eh! eh! eh! is the only accompanying music, if the word can be so employed. Spear in hand, they spring about observing a certain regularity of time and figure—rude but amusing. They are frequently under the influence of spiritous liquors at such times, and this adds to their look of wild excitement. One peculiarity in the Edeeyah is the inclination they feel to work, hunt, or amusement in unison. Thus, whenever it is necessary to employ them on any work, a whole village or town must be employed ; in this way, in a few days an immense deal is cleared away, when they can be persuaded to come together.

Mr Scott, a respectable coloured man, who usually superintended their labours for the West African Company at Fernando Po, informed me that trees of the largest size were easily transported by them to the beach, merely by the habit they have of employing their force simultaneously. Even in the vocal exertions they observe this, and when they chant their incantations to Rupi, either at a feast or hunt, or before working, they use their voices in such exact unison, that it sounds like one stentorian effort, and produces an extraordinary effect on the ear. The first time we heard them thus occupied, it struck us as the most singular unison of vocal power we ever listened to. On such occasions the Buyehrupi uses a sort of wooden rattle, with which he keeps up a noise during the intervals of the performance. The only other instrument of a musical character used by the Edeeyah is a sort of small gourd compressed in the centre, and open at both ends. By blowing more or less forcibly into this, and regulating the fingers or hand at the bottom, such a variety of tones is produced as to enable them to communicate with each other at a distance, and even to hold musical dialogues.

In the still woods of Fernando Po, they are said to be able to communicate with each other at the distance of two or three miles. Having been a witness to some of these attempts, we can quite credit the statement.

Such are a few particulars of this singular people; their classification in the African family will be a matter of future consideration, when a careful examination of the language and comparison with others shall have afforded further data. It only remains to state that, having seen something of the African race on the eastern coast and Mosambique, and not a little of many of the West African subdivisions, we regard the Edeeyah people as at once the most rude and barbarous in appearance, and the most civilised in their laws and social system. When we say appearance, we do not allude to their physical characters, which are superior to most if not all Africans. What is meant, is the rude external adornment of the untutored savage. That they are capable of reaching a high state of improvement cannot be doubted,—their wise and salutary laws go half way to meet the missionary or philanthropist in his exertions; and the amiable dispositions and friendly feelings towards white men would, if expanded by a proper system, soon attach them to their benefactors.

We hope we may not be deemed to anticipate too much when we express the belief that, from the at present little known and centrally-situate island of Fernando Po, much of the civilization of Western Africa will at some future day proceed.

Supplement.—Upon the Edeeyah Vocabulary of Thomas R. Heywood Thomson, M.D. By R. E. Latham, M.D.

The vocabulary of Dr Thomson of the Edeeyah language of Fernando Po, enables me to institute a comparison between it and the languages of the Continent opposite.

My comparison entirely verifies the statement of Dr Thomson of its being an independent language.

With one of the dialects of the Continent, the Bimbia, Dr Thomson's own vocabularies furnish a comparison ready-made. Here there is no affinity on the surface.

With the language of the Cameroons River, the same statement holds good, although it must be borne in mind that we have no accessible Cameroons vocabulary of any length. The longest one known to the present writer is one that was for some time in the library of the Asiatic Society, in MS., and which is now in possession of the original collector.

The Gaboon vocabularies are also scanty. Such as they are, however, they afford no signs of any of the Gaboon dialects being Edeeyah.

As to the language of the Delta of the Niger, we have a multiplicity of specimens in various dialects, the Ibo, the Moko, the Old Calabar, &c. collected by Robertson, Mr Kilham, Mr Daniell, and others. None of these exhibit any special affinity with the Edeeyah.

With the Benin and Yaruba tongues, the affinity is still less evident.

Such is the view of the Edeeyah of Fernando Po, considered in a practical point of view. I have no doubt of its being unintelligible to every tribe of the Continent.

Nevertheless, as it may be this, and yet be no more unlike to such languages than English is to Dutch, or Dutch to Danish, the farther question as to its more general affinities stands over.

Upon this I can safely say that it is by no means an isolated language ethnologically speaking.

It has miscellaneous affinities, with almost all the languages between the Gambia and Gaboon; in other words, it belongs to that great class which, from comparing the Ibo, Ashantee, and other tongues, I call Ibo-Ashantee. The paper that proves this is at present in the printers' hands, for the report of the present author upon the present state of African Ethnographical Philology for the British Association. I have only to add that Dr Thomson's vocabularies both for the Bimbia and Edeeyah are unique, and that they fill an important hiatus in African philology.

On the Gamboge of the Tenasserim Provinces. By the Rev. F. Mason, A.M.

In conversation with a distinguished medical officer, and member of the Asiatic Society, I found that he was not at all aware that the Tenasserim provinces produce gamboge. It has, therefore, occurred to me that a brief notice of the gamboge of these provinces might not be unacceptable to the readers of the Journal, and would contribute its influence to draw attention to a most interesting portion of the British provinces in the east; one that is exceeded by few in the richness and variety of its natural productions.

Three works in my possession describe gamboge, each as the product of a different tree; a fourth represents all to be wrong; and a fifth suggests a different plant still. One refers it to *Cambogia gutta*, a plant which, as described by Linnæus, has probably no existence. He described a Ceylon plant, and it is now quite evident, says Dr Wight, "that the character of the flower and ovary is taken from one specimen, and that of the fruit from a different one, owing to the imperfection of his specimens, and his not being aware that the lobes of the stigma afford a sure indication of the number of cells of the fruit."

Another refers it to *Garcinia cambogia;* but Dr Wight says that the exudation of this tree is "wholly incapable of forming an emulsion with the wet finger;" a statement which the writer knows to be correct. The tree is very common in the Tenasserim provinces, but the bright yellow exudation it produces is certainly not gamboge.

A third refers to *Stalagmitis cambogioides;* but Dr Wight remarks, "the juice of this tree differs so widely in its qualities from good gamboge, that it can never be expected to prove valuable as a pigment."

Dr Graham has described a Ceylon tree under the name of *Hebradendron cambogioides*, which is said to produce good gamboge; but no gamboge has ever been exported into the English market from Ceylon. Thus it would appear, to use the language of Dr Wight, that "the tree or trees which produce the gamboge of commerce is not yet known."

Dr Helfer, who was employed by Government as a scientific naturalist in these provinces, at an expense of 1300 rupees per month, reported, "the gamboge of this country dissolves very little with water, and consequently does not yield that yellow emulsion as the common *guttifera*. It will never serve as a colour, but promises to give a very beautiful varnish." This statement was controverted by a writer in our local periodical at the time, who said he had obtained "fine gamboge of the very best description" from our jungles : in which he was no doubt correct; but he erred when he added that it came from the "true *Stalagmitis cambogioides*." A very small amount of botany would have served to preserve him from falling into this error; for the plant has a quinary arrangement of its flowers, while the arrangement of the flowers in those that produce gamboge in these provinces is quaternary.

The hills that bound the valley of the Tavoy river, on both sides, from their bases to their summits, abound with a tree which produces a fine gamboge. It is Roxburgh's *Garcinia pictoria*, which he knew produced gamboge, but which he said was liable to fade. As soon as I satisfied myself of the identity of the trees by an examination of the inflorescence of our plant compared with Roxburgh's description, I coloured a piece of paper, one band with this gamboge, and another with the gamboge of commerce; and subsequently exposed both to the weather equally for more than twelve months, but without being able to discover that one faded any more than the other. South of the latitude of the mouth of Tavoy river, and throughout the province of Mergui, there is found on the low plains at the foot of the hills, and on the banks of the rivers, almost down to tide waters, another species of garcinia that also produces good gamboge. I have no doubt but it is the tree from which Dr Griffiths furnished Dr Wight with specimens, and which the latter says, "I refer doubtfully to Wallich's *G. elliptica*." We will call it then *G. elliptica*, a species which Dr Wight has on his list of "species imperfectly known." The foliation and female flowers are, however, very well described; and to complete the description, I may add, the male flowers are pedunculated, but the peduncles are shut, and they might be characterised as subsessile. The anthers, like those of the female flowers, are sessile, depressed, or flattened above, and dehise circularly. The ripe fruit is globose, and not furrowed. As I send along with this paper specimens of both the male and female flowers, any of your botanists will be able to correct me at a glance, if I be in error.

Neither Wallich, Wight, nor Griffiths appear to have been at all aware that this species produces gamboge. Dr Wight, in a recent number of his Neilgherry plants, says—"Two species of the genus Garcinia are known to produce gamboge, most of the others yield a yellow juice, but not gamboge, as it will not mix with water." The species which he has described as producing gamboge, and to which I suppose he refers, are *G. gutta* or *H. cambogioides* (Graham), and *G. pictoria* (Roxburgh). That others may be enabled to judge of the character of the gamboge produced by this tree, I have the pleasure to send specimens of its exudation. In its appearance to the eye, and in its properties as a pigment, I have failed to discover the slightest difference between it and the gamboge of commerce. It serves equally well to colour drawings—the Burmese priests often use it to colour their garments, and the Karens to dye their thread. It is also used by the native doctors in medicine, but I think not extensively. Dr Lindley, in his new work the "*Vegetable Kingdom*," says,—"The best gamboge comes in the form of pipes from Siam, and this is conjectured to be the produce of Garcinia Cochinchinensis." As *G. elliptica* is spread all over the province of Mergui, is it not probable that it extends into Siam, and that the Siamese gamboge is the pıoduce, in part at least, of this tree?

There are several other species of *Garcinia* indigenous to the province, but I know of no others producing anything resembling gamboge, except *Gambogia;* the exudation of which, though it will not dissolve in water, dissolves in spirits of turpentine, and forms a very beautiful yellow varnish for tin and other metallic surfaces.—(*Journal of the Asiatic Society of Bengal*, New Series, No. vii., p. 661.)

On the Distribution of the different species of Rocks in the Erratic Basin of the Rhone. By M. A. GUYOT. Communicated by the Author.

We now know, and my preceding communications have, I think, demonstrated, that the erratic Alpine formation is divided into a certain number of groups of rocks, or into erratic basins, whose respective limits are perfectly distinct. But the question is more difficult to answer, whether, in the interior of each of these basins, we can determine a certain order in the distribution of the different rocks there met with. This subject, indeed, can scarcely be said to have been considered at all. Among the few authors who have occupied themselves with the study of the erratic formation, M. J. A. Deluc enumerates a multitude of facts, carefully arranged, without endeavouring to deduce from them any argument for or against the existence of a law of distribution. MM. de Buch and Charpentier have slightly touched the question as it relates to the basin of the Rhone. The former seems to answer it in the affirmative, with regard to the granites of Mont Blanc and the pudding-stones of Valorsine. The latter, who admits a law of distribution for the erratic rocks in the interior of the valley of the Rhone, appears to deny all regularity in the appearance of the same species which cover the plain; but M. Studer, on the contrary, believes that he has found one in the basin of the Aar, in the space which lies beyond the high Alps. The facts which I have observed in all the erratic basins, and especially in those of the Rhine, the Reuss, and the Rhone, have led me to these results:—

1*st*, That the distribution of the species of erratic rocks in the interior of each basin is subject to a law which has the same influence in the plains as in the valleys.

2*dly*, That this law is the same in all the basins.

But it is of the last only of the basins I have named that I wish to speak at present.

The variety of rocks, differing as much in appearance as in mineralogical character, presented by the basin of the Rhone, and the large scale on which the phenomenon is exhibited, render this basin an excellent field for a study of this nature. On the other hand, its double divergency and double outlet, on the east and west, complicate the question, by introducing an element not found in the other basins, and which it is necessary to be particularly careful in taking into account. I shall first notice briefly the principal species of rocks which distinguish the basin of the Rhone, then examine what is the mode of association and distribution peculiar to each of them.

Characteristic species.—The rocks which I consider as truly characteristic of this basin, without belonging to species very distinct, nevertheless form everywhere groups identical with themselves, and perfectly recognisable. They are essentially the following:—

1. A species of granite, or, if the term be preferred, talcose syenite, of a yellowish-green colour, composed of a talcose, chloriteous, and most frequently slaty mass, intermixed with numerous crystals of quartz, felspar, and amphibole, and sprinkled here and there with very small crystals of sphene. Pretty frequently it affects the structure of gneiss, or even slate; in the latter case, the quartz and amphibole, and even the felspar, gradually disappear, and the rock passes into a sort of chloriteous slate. This rock is the talcose granite of M. De Charpentier, the sphenitic rock of M. De Buch; I shall designate it by the single word *Arkesine*, a name which M. Jurine has given to a rock very analogous, of which I have found some specimens in the collection deposited in the museum of Geneva.

2. A species of gneiss, very rich in white felspar imperfectly crystallised, with broken or undulated scales of chlorite, of a fine light green, sprinkled with very shining particles, and containing crystals of quartz, few in number, and irregularly distributed. By the disappearance of the quartz, which is often wanting, this rock passes into a sort of chloriteous leptinite; by the diminution of the felspar to a very minute quantity, and the predominance of the chlorite, it approaches to a simple chloriteous slate. I shall call it *chloriteous gneiss*.

3. *Chlorites*, of a light or dark bluish-green, usually slaty, appearing as if regularly pricked with a great number of granules of white or yellowish felspar, of very variable

size. It is these chlorites which I have hitherto named *roches de Bagnes*, because they constitute, in a considerable degree, the great chains which traverse the upper part of this valley and its neighbourhood.

These three species are found too uniformly together throughout the whole extent of the basin of the Rhone not to have primitively belonged to the same localities. They form a group by themselves, which I shall call, by way of eminence, the *Pennine rocks*; for I have satisfied myself that it is in the highest summits of the Pennine Alps that they have their primitive seat.

M. De Charpentier had announced, on hearsay, that arkesine, or talcose granite, came from the valley of Binnen, in the Haut-Valais, and especially from the chain which separates this valley from Val-Antigorio. I have traversed this valley, and the Col de Albrun, which leads to Antigorio, without meeting with a single fragment which reminded me of this well-marked rock. MM. Studer, Escher, and Desor, have examined the two chains which border this valley, from Valais as far as Val-Divedro, without finding it. I was therefore ignorant, when starting on my last expedition among the Alps, whither I should go to seek for it. Guided by the law of distribution which I had recognised in the plain, and by the constant association of this rock with those of Mont Rosa, I directed my steps to the bottom of the valleys of this enormous mass, and there, above the Glacier of Zmutt, I at last found it in great abundance, forming a vast moraine on the left flank of the valley, at the very limit of the polished rocks, at a height of 9000 feet. This train, which I followed for the space of a league, evidently came from the near regions of the Dent Blanche and Dent d'Erin.

I again found the arkesine in the Val d'Erin in equal abundance. The only two specimens of this rock in the rich collection at Berne, were brought, the one from these same regions of the Dent d'Erin, where it was found by M. Forbes, the other from the bottom of the valley of Bagnes, from the Glacier of Chermontane, where it was procured by M. Studer. At the Glacier of Zmutt, as in the Val d'Erin, the chloritic gneiss, with all its varieties, accompanies the arkesine. We may therefore assert that these rocks belong to the great metamorphic chain which, according to M. Studer, constitutes the greater part of the enormous masses of the Pennine Alps from the valleys of Bagnes and Entremont, as far as that of Viege and beyond it.*

With regard to the granular chlorites, or Bagnes rocks, their original site is determined long since. Although descending in greatest abundance by the valleys of Bagnes and Entremont, they are found throughout the whole extent that I have indicated, all varying much. They pass by different degrees to slates, more or less talcose, often with a filamentous structure, and they are found under these diverse forms in the southern chain as far as the Haut-Valais. The arkesine, on the contrary, and the chloriteous gneiss, never appear higher than the valley of Viege, which is occupied by the rocks which have descended from the valley of Saas.

We may join to this group of the Pennine rocks, properly so called, that of the rocks of Mont Rosa, which likewise contains three species particularly characteristic.

4. *The Euphotides of Saas* are here placed in the first rank. This beautiful rock, whose varieties, more or less rich in Saussurite, Smaragdite, and yellow or white talc, are very numerous, is distinguished from the rare euphotides or granitones of the basins of the Isère and Rhine. It is spread over almost the whole surface of the basin of the Rhone, and is, notwithstanding, known to be derived from the valley of Saas alone. It descends the high ridges of Saasgrat by one route, the glacier Alalein, behind which I could not perceive a single fragment. This exclusive origin, joined to its

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* These conclusions have been fully justified, and placed beyond all doubt, by my investigations last summer (1846). I traversed the whole high chain of the Pennine Alps, still so little known, from Mont Blanc to Mont Rosa. I either reached or crossed the ridge at five different points. I examined the bottom of all the valleys on the northern side, from the valley of Bagnes to that of Saas, as well as a part of those on the southern slope; and I had the great satisfaction of discovering at last, in these almost inaccessible peaks, the precise site of all the characteristic rocks of the erratic basin of the Rhone which are here enumerated, and to collect them *in situ*. I shall give an account elsewhere of the result of these researches, which complete the series of my studies on the Swiss erratic formation.—See p. 319.

great diffusion, renders it of much value for distinguishing the basin of the Rhone from contiguous basins.

5. The *Eclogites*, faithful companions of the euphotides, and not less characteristic, also come exclusively from the same localities. The base of this rock seems to be a sort of granular amphibolite, of a greyish-green, imperfectly slaty, sprinkled regularly with small grains, from one to four millimeters in diameter, so numerous that they form an essential part of the rock, and with brilliant spangles of silvery mica, likewise numerous, of the same size, and remarkable for their regular distribution and generally rounded form. This rock, as widely distributed as the euphotide in the form of pebbles and small blocks, is seldom found in blocks of large size, although it descends, like the euphotide, by the glacier Alalein; I have likewise found it to the west of Saasgrat, in the moraines of the glacier of Finnelen.

6. The *Serpentines*, compact and slaty, belonging to the mass of Mont Rosa, may be ranked among the rocks characteristic of this great Pennine chain, and of the basin of the Rhone. For, although it may be alleged that some of them are likewise found in the neighbouring basins of the Arve and Isère, they will always afford distinct indications, by their particular varieties, abundance, and association with rocks of a less questionable origin than themselves.

The two preceding groups represent, in the plain, the great central or Pennine chain; the following species essentially represent the lateral masses of Mont Blanc and of the Bernese Oberland.

7. The *granites* of the basin of the Rhone, forming gigantic blocks scattered on the declivities of the Jura, and which having been the first to attract the attention of the learned world, it is natural that they should have been considered as the principal and most characteristic rock of this basin. Such, however, is not the case; for not only are they less generally diffused than the Pennine rocks, but some of them are common to it with the basin of the Arve, and others are very analogous to those of the basin of the Aar.

These granites are essentially of two sorts.

One of them has a base of white felspar, sometimes very slightly tinged with violet, in large parallelopipedal crystals, often *mâcles*, or twin crystals, with quartz faintly violaceous; amphibole and a chloriteous substance usually replace the mica, which is rare, and form here and there masses of a dark-green, the size of which varies from an inch to a foot and upwards. We should then be disposed to say that a fragment of a foreign rock was imbedded in the mass of granite. Lastly, a talcose substance of a light-green, with an earthy appearance, communicates its colour to a part of the mass. These are the protogines of the chain of Mont Blanc, of which there are many varieties, owing to differences in the development of the crystals, in the structure, and in the abundance of the talcose parts. Although these varieties seem to be found in many parts of the chain, it may be said, in general, that the protogines which are distinguished by the disproportionate size of their crystals of felspar and gneissitic structure, belong to the needles of Chamounix, on the north-west declivity of the chain; those of Val Ferret, on the north-east declivity, have a more equal grain, although the crystals are still very much developed. The protogines with small grains, poor in talcose portions, or passing into true gneiss, are found chiefly in the extreme north, between St Maurice and Martigny, as in Mont Catogne.

The second kind of granite differs from the preceding in many characters. The crystals do not exceed a medium size; they are also more confusedly crystallised, and are never *mâcles*, or twin crystals. The mica, or the substances which occupy its place, is more disseminated and of a lighter green. These granites rarely contain dark masses imbedded in their substance: when they do, they are inconsiderable, and less distinctly defined on their edges. The talcose portions are often by no means abundant, and the aspect of the rock generally whiter. These granites come from the glacier of the Rhone and the mass of the Bernese Oberland, descending by the glaciers Viesch and Aletsch, and following the right bank of the Valais, whence their analogy with those which issue from the same masses by the valley of the Aar.

8. *The Pudding-stones of Valorsine*, which the beautiful observations of Saussure have rendered celebrated, are one

of the kinds of rock most distinctive of the basin of the Rhone. They are composed of a sandstone, often slaty, of a fine grey, very micaceous, sprinkled here and there with slaty spots, of greater or less size, and of a deep and dull black, interposed between the laminæ. These sandstones contain pebbles and fragments of quartz, gneiss, and other primitive rocks, the size of which varies from that of fine gravel to the bigness of the head. These pebbles are usually so numerous that the slaty structure disappears, and they are so firmly cemented that the hammer cannot detach them without breaking their bed, and at the fracture they appear like spots whose edges are not always clearly marked. The whole forms a rock of great hardness. Their primitive site is not confined to the valley of Valorsine; the rock is likewise *in situ* on the right bank of the Rhone, above Outre-Rhone, near the Dent de Morcles, and on the mountain of Foully. In two localities it is accompanied with conglomerates and schists of wine-red, belonging to the same formation. It is from the latter, that is, the right side of the valley, that the greater part of the numerous blocks of this species which are in an erratic state in the basin of the Rhone, seem to have been detached.

9. We must, in the last place, indicate, as a character of the basin of the Rhone, which no other neighbouring basin shares with it, at least in the same degree, the remarkable abundance of pebbles of all sizes, of a quartz usually yellowish, which are distributed over the entire surface, and the presence of which, at the outskirts of the basin, invariably announces the proximity of other erratic rocks.

Distribution of the Species.—The distribution of the species I have named in the plain is by no means accidental. Here also there is no disorder, no absolute mixture, but an order and a method, which takes place according to certain laws. No doubt we cannot look here for distinct limits of distribution, like those which separate the different basins, but we can lay down the following propositions :—

1. A particular species abounds in one region of the basin, and is found rarely, or not at all, in another.

2. The blocks of diverse species, on leaving the place of their origin, have a tendency to form parallel series, and when they reach the plain, they spread considerably, but do

not fail to preserve a respective disposition, analogous to that which they occupied in their primitive sites. The blocks of the right flank of the valley occupy, in the plain, the right side of the basin; those of the left flank, the left side; those of the most central valleys cover the central regions of it.

3. Groups composed each of a single species of rock to the exclusion of every other, are found here and there in the midst of rocks of various species, but always in conformity to the conditions of the preceding rule.

A word on the distribution of each of the species I have described will afford proof of this.

The Pennine rocks, the arkesine, chloriteous gneiss, and granular chlorites, are by far the most widely diffused; they cover three-fourths of the surface of the basin. We have said that they always go together, and form a group which conducts itself almost like a single species. If we take them at their point of departure from the mouth of the valley of Viege and Val d'Erin, we see them follow the left flank of the valley of the Rhone, without ever passing to the opposite side. At the outlet of the valleys of Entremont and Trient they are joined by the granites of Mont Blanc, which accompany them, and form the outer border. On issuing from the valley of the Rhone, they spread themselves in the plain in a vast fan-shaped expansion, and fill the basin of Leman, and that of the lakes Neuchâtel and Bienne. We find them at the same time along the exterior slopes of the Chablais chains, at the foot of the Salève, in the whole of the plain of Geneva; they crown Mont De Sion with prodigious blocks. They constitute the great majority of the large blocks suspended on the back of the Jura from Fort Ecluse to the foot of the Dôle, as well as the less numerous blocks scattered in the plains in the country of Gex and the heights of De la Côte, as far as the vicinity of Lausanne. Further to the east, these same rocks, but in blocks of smaller size, and comparatively less frequent, strew the slopes of the Jura, and form, along with the granites of Mont Blanc, the superior limit of the erratic formation. In the plains, where granites scarcely appear, they again predominate, and cover with their debris the whole plain of the Aar, the molassic hills between Soleure and Berne, and extend to the environs of Zoffingen and Arbourg, where measurable blocks of chlorites may be considered the last representatives of the Pennine rocks, and mark the extreme limit of the extension of the basin of the Rhone.

Still further, these rocks are the only ones which penetrate into the interior of the high valleys of the Jura. Beyond the superior limit of the erratic formation, indicated in the Jura of Neuchâtel and Vaudois by large blocks of granite and the existence of polished surfaces, beyond the two or three first chains, and still further, we encounter in the bottom of the high valleys, at a height of more than 3500 feet, an erratic formation, composed of fragments and blocks, the largest of which scarcely measure a metre, accompanied with numerous quartz pebbles.

These fragments are usually very angular, yet have an indescribable appearance of great age; the rock seems greatly altered. They appear to have been buried for a longer or shorter time under the earth, where they are still found for the most part. Yet the rocks composing this erratic formation, which may well be called insulated and distinct from the rest of the basin, are still exclusively the Pennine rocks. Not one granite from Mont Blanc, nor one pudding-stone of the Valorsine, penetrates into this inclosure, defended by the high chains of the Jura. The valleys open towards the plain, such as those of Vallorbe, Val de Travers, Val de Ruz, are the only ones of the Jura into which the latter penetrate. The quartz only, in numerous pebbles of all sizes, accompanies the Pennine rocks into the interior of the Jura, and thus become, along with them, the last and most distant representatives of the Alpine rocks over the whole of this extremity.

But although these three species of rocks thus act a common part, we can, nevertheless, remark a difference in their distribution, which confirms the law indicated above.

The granular chlorites, which come in greatest abundance from the lower part of the valley of the Rhone, have a tendency to preserve their exterior position along the left bank of the basin. They are found in greatest plenty, and in blocks of the largest size, in the western part of the basin.

They ascend very high on the chains of the Chablais, without, however, attaining the height of the granites, but leaving below them the arkesines, which occupy chiefly the foot of these heights. They still appear in blocks of many metres on Mont de Sion. Above the country of Gex, on the confines of the Vaudois and Neuchâtelese Jura, on the Suchet and Chasseron, they reappear more frequently and in large blocks. But more to the east the blocks are smaller and less numerous, and more talcose varieties, in which all granulation gradually disappears, become substituted for the true granular chlorites.

The chloriteous gneiss, although abundant, rarely forms large blocks; its presence is more intimately connected with that of arkesine; and we may consider what we are about to state as to the distribution of the latter rock, as applicable to it also.

The arkesine, with its analogues, is the most widely spread of these three rocks; its true domain is the south-west part of the basin. We find it along the Savoyard side of the Lake of Geneva; it forms the great majority of the blocks on Mont de Sion, Vouache, and the country of Gex. More to the east, it accompanies the granites of Jura, in blocks still numerous, but of much smaller size. In the plain we find it abundantly between Neuchâtel, Fribourg, and Berne; it forms, almost by itself, some leagues from Soleure, the largest blocks known, not only in the basin of the Rhone, but in all Switzerland, such as the great block of Stienhof, and, quite near to that, those of Steinberg.

Thus, then, the Pennine rocks are found almost throughout the whole extent of the basin. No region is exempt, unless it be the right side of the valley of the Rhone, and beyond the Alps, the countries situate at the foot of the mountains of Gruyère. Everywhere the chlorites abound, particularly on the left bank of the Lake of Geneva, while the arkesines, along with the chloriteous gneiss, prevail in the central portion of the basin, especially, on the one hand, on Mont de Sion and in the country of Gex, and, on the other, at the extremity of the north-east, in the plain to the south of Soleure. The respective situation of the regions where the one or other of these three erratic species predominate, is thus, beyond the Alps, the same as is observed to exist among the Alpine valleys whence they derive their origin.

The rocks of Mont Rosa, in like manner, act as if they were one species. They follow very nearly the attraction of the Pennine rocks, and accompany them almost everywhere in the state of pebbles; but they do not follow them to the greatest heights, appearing to prefer the plain or the lower sides. The considerably-sized blocks of these rocks are found chiefly in the western part of the basin. The plain of Geneva, and the slopes which bound it, the country of Gex, and particularly the neighbourhood of Nyon, are their true domain. There only we meet with blocks of euphotide from two to five metres in length, and masses of serpentine still longer. Beyond this limit, in the eastern part of the Pay de Vaud, and further to the east, blocks of euphotide become very rare; the most remote I have met with on the sides of the Jura, were found above Neuchâtel and Neuveville, and they scarcely reach the dimensions of a metre. The same thing may be said of the serpentines. Both of these rocks, however, and the serpentines in particular, reappear in abundance and in large blocks between Berne and Bourgdorf, where they give a character to an entire region of the basin. With regard to the eclogites, I am acquainted with no large blocks of it. It is usually found in blocks of small size, scarcely measurable, and most frequently in pebbles of very variable dimensions.

We see that the two regions in which the rocks of Mont Rosa are most abundant, are both on the right of those in which the Pennine rocks predominate. Here, also, we again find in the plain a disposition of the erratic rocks which recalls the relative situation of the valleys from which they descended.

The distribution of the granites of Mont Blanc presents some remarkable characters. We find them, at the same time, at the superior limit of the whole erratic formation, along the left side of the basin, on the heights of Chablais, and along the opposite declivities of the Jura. This latter locality even appears to be, contrary to all expectation, the special domain of this rock. From La Dôle to beyond Soleure, in the neighbourhood of Niederbipp and Aarwangen, not only do blocks of granite predominate both in number and size, but they are arranged in continuous bands with well-defined limits, excluding everywhere all other species of rock. This takes place more especially in the Neuchâtelese Jura, where this disposition is more distinctly exhibited than in any other place.

On the flanks of the Chaumont chain, indeed, the upper limit of the erratic formation is composed of a zone of granite blocks, the largest of which measures ten metres. This zone is prolonged, always becoming lower to the east side, on the heights of Chaumont to the foot of Chasseral, near Nods and Lignières, then by the valleys of Orvins and Vauffelin. It is mingled with numerous blocks, but relatively of small size, of the Pennine rocks. Below this first zone is an interval of upwards of a thousand feet in height, altogether destitute of large blocks: with difficulty we observe here and there a few representatives of the Pennine rocks. But we soon meet with a second zone nearly twenty *minutes* broad, which covers the plateaux of Pierre-a-Bot with a quantity of blocks quite as large and numerous as those of the former zone. It is to this zone that Pierre-a-Bot belongs ; it is eighteen metres in size, and there are a great number of others almsot of equal dimensions. This band is prolonged to the east and west in all the country of Neuchâtel, and forms, a little above Boujeau, near Bienne, one of the finest deposites of this kind to be met with on the declivities of the Jura.

Two species of rocks only form this train of huge blocks, namely, the protogine of Mont Blanc, with very large crystals of felspar, coming from the needles of Chamouni, and, in general, the western declivity of the chain, accompanied by a kind of grey gneiss or very hard mica-slate, of which I have found examples in the chain of the red Aiguilles of Chamouni. The inferior limit of this zone, which, in the vicinity of Neuchâtel, is five hundred feet above the plain, is distinctly marked. After passing it, we immediately find the arkesines, chlorites, euphotides, &c., reappear.

These two zones may be followed to a distance, to the east and west ; but they are not everywhere so distinct. The upper zone always forms the superior limit of the erratic formation; it turns round Chaumont, enters the Val de Ruz, at the bottom of which it is marked by an accumulation of large blocks near the village of Pasquier, follows the heights of Planches, the foot of the Pic de Tete de Rang, the elevated meadows of Champs-devant, passes into the Val de Travers, where it forms everywhere the circumference of the valley, as far as the tower of St Sulpice, where there is a crown of blocks at the same level. The granites extend to the entrance of the valley of Verrières, without entering it, and terminate suddenly below Côte-aux-Fees without ascending the plateau, while these two valleys contain pretty numerous fragments of altered Pennine rocks.

The zone of granite then ascends the mountain of Boudry, describes a semicircular curve in the bottom of the hollow of Provence, of which the Prises and high pasturages are as it were inundated with immense blocks, notwithstanding the continual efforts of the agriculturalist to destroy or to bury them. In this anfractuosity, the interval between the two zones disappears, but their position is still indicated by a greater abundance of large granitic blocks at the summit and bottom of the side. This double cincture continues to be drawn, with the analogous phenomena, on the flanks of Mont Aubert; the granites rise to the village of Mont Borgeais, near which the great block of Pidouse indicates nearly the upper limit. The latter attains its maximum height on the plateau of Bullets, whence it gently descends by Sainte Croix on the eastern declivities of the Aiguille de Beaumes. From that point, the large blocks of Suchet, those of Granges de Valorbe, which measure twenty metres, the numerous blocks of the plateau De Premier, those of Mont la Ville, celebrated for their great dimensions, and lastly, those which conceal the forests of Mont Richer, by their numbers, everywhere mark out the permanence of this grand girdle of granites, which gradually descends lower, and becomes more and more intermixed. Still further, toward the west, these same granites do not cease, but from Dôle more especially, the blocks become less numerous, much smaller, and yield the preponderance to the Pennine rocks. We still find them, it is true, throughout the whole extent of the plain of Gex and Geneva, but they are sporadical, mixed, and no longer in the zone of the large blocks like that we have just described.

In this girdle of the large blocks of the Jura, it is the varieties which must have issued from the valley of Trient which predominate. Those of the Val Ferret are rarer, and are found rather below the two zones towards the plain. This arrangement, and the fact that the lower limit of the zone of blocks is distinctly defined, even in the midst of the forests and uncultivated rocky places, prevents us ascribing, as has been done, the absence of the large blocks in the plain solely to the hand of man and the progress of cultivation.

The granites of Haut Valais, or those on the right flank of the valley, occupy a very secondary place in the plain. Pretty numerous in the Valais on the right bank of the Rhone, in the plain they are superseded by the pudding-stones of Valorsine towards the interior of the basin. They follow a curved line which passes along the Jorat between Lausanne and Vevey, turn slowly to the east on the plateaux which surround Moudon, then follow the heights to the north of Romont, and rejoin the Alps of Fribourg at the foot of La Barra. The greater part of the granites which are scattered in small numbers to the north of this line, as far as the neighbourhood of Neuchâtel, Fribourg, and Berne, seem to have this origin.

On the other hand, I think I may rank in this class a considerable number of granite blocks, met with on the plateaux which overlook Morges, near the village of Bussy, and as far as Aubonne and the plains of Bière. These blocks might form a second zone running from the east to the west on the heights of Jorat, parallel to the banks of the lake, as if to rejoin the Jura.

The pudding-stones of Valorsine, along with the red or wine coloured conglomerates, have a more distinct domain than any other rock. They occupy by themselves the right side of the basin, from the mouth of the valley of the Rhone, and cover the plateau of Jorat, as far as the environs of Lausanne. The red conglomerates keep almost exclusively at the upper limit of the erratic formation, along the extreme right side on the heights of the chain which overlook Semsale, on the Moleson and La Barra. We again encounter them even beyond Guggisberg. The blocks of Valorsine, properly so called, occupy the heights which overhang Vevey, to the exclusion of almost every other rock. They form a broad zone, which, on issuing from the valley, bends to the north-east, and covers all the country between the Alps on the one side, and the heights to the north of Rue and Romont, to the neighbourhood of Fribourg and Guggisberg. We likewise find them very numerous, and even predominating, but mingled with the Pennine rocks and granites, on the plateau between Lausanne and Yverdon, and on all the southern bank of the lake of Neuchâtel. They are rare on the northern bank of this lake and at the foot of the Jorat, where they rarely ascend to any height. We may mention, as a phenomenon, a block of this rock, of two or three metres, situate 400 feet above the lake of Neuchâtel, in the little valley of Vert, near Boudry. To the east of Berne and Aarberg the Valorsines are very thinly scattered.

The western part of the basin is by no means entirely destitute of them; they occur to the west of Lausanne and Yverdon, as far as Aubonne, and near the Jura. A few appear here and there in the plain of Geneva; but these no doubt come from the left bank, from the valley of Valorsine and Trient. In no part of these regions are they so abundant as to impart a character to it, and the size of the blocks is never very remarkable.

Quartz Pebbles. If I have given a place to quartz pebbles among the most characteristic rocks, it is because there are few rocks so generally and uniformly distributed in the basin of the Rhone. The quartz, however, appears most ready to accompany the Pennine rocks. Beyond the limits of the blocks, on the Jura, when every other rock has disappeared, we still find a quartz pebble here and there, even to a height of 4000 feet, as on the summit of the chain of Creux du Vent, between Provence and Motiers; on the ridge of the chain of Tete de Rang, between Val de Ruz and the valley of Sagne; on the heights of Pery and Du Monto; on the chain which separates the valley of Langenbruck from Œsingen, and elsewhere.

The quartz pebbles are thus the only vestiges of the erratic formation which connects the region of the exterior blocks of the Jura with the erratic formation, as we find it insulated in the bottom of the high valleys of this chain. Here they are associated with the Pennine rocks as usual, but they are proportionably more abundant. Lastly, no rock appears in more numerous fragments, nor so far from the Alps. When placed beyond the erratic basin of the Rhone, we approach the regions which it occupies in Savoy, in the Jura, as in Argovia; everywhere we encounter, on the outer margin, the quartz pebbles as the avant-coureurs of the Alpine rocks. It is in this way, that at the eastern extremity of the basin, and most remote from the primitive sites, in the vicinity of Urkheim and Zofingen, not far from the spot where we leave the predominating erratic rocks of the Reuss, a great abundance of quartz pebbles suddenly announces the approach of the basin of the Rhone. They are alone at first, but a few hundred metres further on, some granular chlorites shew themselves; the talc schists and granites finally succeed these, and no longer leave any doubt that we are in the basin of the Rhone. This abundance of quartz pebbles is so much the more remarkable, because the blocks of this rock are rare and of small size. Perhaps their number is owing to their almost indestructible nature, and the absence of large blocks to their being produced by veins rather than from massive rocks.

To shew briefly the distribution of the species of rocks in the basin of the Rhone, let us cut the basin transversely to the east at first, than to the west of the outlet of the valley from which they issue, each time leaving the Alps to emerge on the Jura; each of these sections will shew us clearly the order of succession which the rocks observe. I draw the first from the neighbourhood of Bulle to Mont de Boudry, near Neuchâtel; the second from Fourches d'Aberre, in Chablais, to Marchairu.

On leaving the Alps, above Bulle, we find, on the height, the wine-coloured conglomerates which form the superior limit of the erratic formation and the extreme right bank of the basin. Along with these the Valorsine region of blocks commences. Beyond Romont and the valley of La Glane, on the heights which separate this valley from that of La Broye, some whitish granites of the Haut Valais mingle with the pudding-stones of Valorsine; we then see the euphotide blocks of Saas, accompanied with the talcose chlorites and serpentines of Mont Rosa. In the space comprised between Broye and the banks of the lake of the Neuchâtel, the arkesines and chloriteous gneiss are joined to the preceding rocks. On the north bank, beyond the lake, the latter and the chlorites become predominating; the Valorsine rocks have almost disappeared. On ascending the sides of the Jura, from five or six hundred to a thousand feet above the lake, and not till then, the granites of Mont Blanc make their appearance. It is the inferior zone of large blocks.

Lastly, above a space of nearly a thousand feet in height, in which almost all the Alpine rocks disappear, the superior zone of the large blocks of Mont Blanc, with which the Pennine rocks are intermixed, forms the most elevated limit of the erratic formation.

We must therefore distinguish three principal regions in this section; that of the Valorsine pudding-stones along the Alps; that of the blocks of Mont Blanc along the Jura; and those of the Pennine rocks, preceded by some granites of the Haut Valais and rocks of Mont Rosa, in the centre.

The section across the western part gives us an analogous series.

The heights of Chablais, in the neighbourhood of the outlet of the Dranses, shew us the granites of Mont Blanc, less numerous, however, than might be expected in the upper part; and allied to the chlorites which rise almost to the same level. Further down, the arkesines and chloriteous gneiss form a junction with them, on the slopes which overlook Thonon, Evian, and La Tour Ronde; but the euphotides and serpentines are still rare. Beyond Leman, to the south of Aubonne, and near Nyon, the rocks of Mont Rosa are very abundant. Lastly, at a greater distance, towards the Jura, we meet with the white granites of Haut Valais, the pudding-stones of Valorsine, and granites of Mont Blanc, mingled with the preceding rocks, but predominating.

Here, again, we observe the rocks succeed each other in the same order as in the preceding section; and this order is that in which these same rocks have advanced from below upwards into the principal valley. First, the granites of the left bank and of the lower part of the valley; then the chlorites of Bagnes, the arkesines and chloriteous gneiss of Val d'Erin, the serpentines of Mont Rosa, and the euphotides of Saas, and lastly, confusedly mixed, the rocks of the right bank with the granites of Mont Blanc, which belong, as we shall afterwards see, to the effusion of the eastern part.

It is therefore correct to affirm, as I did at the outset, that the distribution of the species of erratic rocks is subject to a law, according to which the transported debris of rocks of the same species preserve in the plain a determinate position, which is assigned to them by the respective situation of the valleys from which they issue. The rocks which proceed from the lateral valleys, nearest the opening of the principal valley, keep the margin on one side or the other; such as proceed from the most remote tributaries remain in the centre.

This law of distribution I have also observed to hold true in the basin of the Rhine, and more distinctly still in that of the Reuss, which is more simple than the two others; but a circumstance which is peculiar to the basin of the Rhone is the double divergency of which I have spoken. We may perceive that each of the two branches, eastern and western, represent, in their order, the rocks of the valley of the Rhone considered collectively. Now this disposition compels us to admit two periods of divergency. During the first, the issue took place only on the north-east side, that is to say, on the most open side of the great valley lying between the Alps and the Jura. In a second epoch, the effusion must have taken place by the much narrower basin of Leman, towards the plain of Geneva and the country of Gex.

The analogy between this distribution and that of the moraines of a glacier, is evident, and must strike every one. The arrangement in linear series, which the superficial moraines affect, the uniformity of the respective situations they preserve, in spite of all the angles and contours of the valley, their expansion, and gradual, but always incomplete mixture, in the lower part where the glacier spreads itself; all these phenomena, so distinctly marked on the surface of every one of our existing glaciers, are precisely those presented, though on a gigantic scale, by the surface of the erratic basin of the Rhone. Let us imagine for a moment, the existence of this vast glacier of the Rhone, and let us take it at the instant, when, in consequence of its progression, it has carried the rocks of the Alps to the extreme limit where we now find them, and let us observe what would be the distribution of the superficial moraines which we find on the surface, according to the acknowledged laws of the mechanism of glaciers.

In a primeval era, that of its greatest extension, all the space comprised in the acute angle formed on the south-west by the union of the Alps and Jura, is encumbered with masses of ice, fed by the valleys of the Isère, the Arve, the Dranse, and the Rhone. The outlets are insufficient; escape by this side is almost impossible, at least for the ice of the valley of the Rhone. A divergency, therefore, takes place by the north-west, where the plain opens and becomes broader by the gradual retirement of the two chains. The principal mass of the glacier rests upon the Jura, which throws it back towards the plain, in which the ice spreads itself more at ease, and seems even to recoil slightly towards the Alps. Here it meets with a new obstacle, the glacier issuing from the valley of the Aar, which presses against the glacier of the Rhone, and compresses it, without otherwise arresting its progress. Lastly, the ices of the Valais, diminishing more and more, at length terminate not far from Aarwangen and Zofingen. Such, then, is the prodigious glacier of the Rhone.

The moraines distinguishable on this glacier are, 1*st*, The right lateral moraine, composed almost exclusively of numerous blocks of Valorsine pudding-stone, detached from their principal site on the declivities of the Dent de Morcles; they extend along the Alps from Fribourg as far as Singine. 2*d*, The moraine of Haut Valais, characterised by the white granites, from the southern declivity of the Bernese Oberland and the Galenstock. 3*d*, The moraine of Mont Rosa, with its euphotides and serpentines, among which a few Pennine rocks are already mingled. *4th*, The moraine of the Pennine Alps as far as the foot of the Jura. *5th*, The left lateral moraine, formed by the granites of Mont Blanc, which have united themselves, by way of Martigny and the Valley of Salvan, to the other rocks of the basin.

This last moraine is of much greater length than the right lateral moraine. This circumstance, as well as the general inflexion of the interior or superficial moraines, is the necessary consequence of the movement imparted to the ice by the configuration of the bed in which it moves; we have seen it above.

The line which leaves the foot of the Alps of Guggisberg, forms the limits of the basin of the Rhone, at its contact with that of the Aar, and extends even beyond Aarwangen, is not, in spite of appearances, the continuation of the right lateral moraine, but rather the frontal, which, at first sight, one would have been disposed to seek on the opposite side, on the Jura itself. It is not that we find here, any more than elsewhere, an accumulation which reminds us of the frontal moraines of many existing glaciers; but it is on this line that all the moraines we have named have rested a-breast. Instead of finding only the rocks of the right side on this boundary, as would be the case if it were only a prolongation of the lateral moraine, we find, in passing along it, the rocks of all the rest, and in the order indicated: the Valorsines at Guggisberg; the granites of Haut Valais, between Schwarzenbourg and Köniz; the euphotides and serpentines in the neighbourhood of Berne and Bourgdorf; the arkesines and their companions, at Seeberg and Steinhof; the granites of Mont Blanc near Arwangen.

At a posterior epoch, the flow of ice took place nearly in a south-west direction by the basin of the lake of Geneva, and the same phenomena are here repeated. Here, as in the eastern part, the blocks of Mont Blanc, coming down by Salvan and Martigny, form the left lateral moraine. In the Valais and in Chablais, the chlorites mingle with them, soon become predominant, and form the limit at the bottom of the Voirons, on the northern declivity of the Salève, and as far as Mont de Sion. The Pennine rocks form a large central moraine, partly immersed in the waters of the lake, and which covers the plain of Geneva, and Pays de Gex, as far as Mont de Sion and the Jura. The moraine of Mont Rosa, marked by a greater abundance of euphotides, serpentines, and secondary rocks of the same group, passes along the vicinity of Nyon and Coppet, running in a westerly direction as far as the very foot of the chain. The moraine of Haut Valais, characterised by numerous and huge blocks of white granite, is the beginning of the right lateral moraine, passing by Morges, Bussy, Aubonne, and Bière. Lastly, the Valorsines, particularly numerous in the environs of Lausanne and Cossonay, and often in connexion with limestones, form the extreme right lateral. The granites of Mont Blanc, which are found in the latter regions, and as far as the Jura, undoubtedly belonged to the left lateral moraine during the period of the first divergency, and must have been carried to the west at the time when the change of direction in the progress of the glacier took place.

In this part of the glacier, we may consider the blocks accumulated at the extreme limit of the basin, on the summit of Mont de Sion, from the road to Frangy, along the declivities of Vouache and the Jura, as far as the vicinity of Faucille and Divonne, as the frontal moraine; for, in the whole of that space, we scarcely meet with anything else than the Pennine rocks and those of Mont Rosa.

Here, again, as in the eastern part, the left lateral moraine is more extended than the right lateral moraine; but the disproportion is far from being so great, a circumstance perfectly accounted for by the relief of the basin.

It is thus that we explain, by this successive effusion of the glacier in two opposite directions, the complicated but still normal distribution of the species of erratic rocks of the basin of the Rhone. The order of succession appears to me fixed, not only by the nature of the reliefs, as I have explained above, but still further by that of the rocks themselves. Although the characteristic rocks are the same in the eastern as in the western portion of the valley, yet we scarcely find among the former any others but the species which come from the highest summits of the Alps; while, in the latter, these same rocks are accompanied by a much greater variety of rocks, which I call secondary, and which generally proceed from a part of the mountains below the elevated summits. We ought thence to infer, that the rocks of the eastern part were detached when the highest summits rose alone from the bosom of the ice, while the rocks of the western part have fallen on the glacier when the inferior rocks were uncovered, and yielded their contingent of very varied rocks. Now, the whole mode of the deposition of the erratic formation, and the angular blocks it contains, presenting themselves like a phenomenon of continued retreat since the period of the greatest extension of the diluvian ice, it follows that the deposites of the eastern part of the basin represent the beginning, those of the western part the end, of this long erratic period.

Conclusions.—The facts which have been explained authorise us, in my opinion, to affirm—

1*st*, That the distribution of the species of rocks in the interior of the basin of the Rhone is subject to a law.

2*d*, That this law is, in all respects, conformable to that which regulates the arrangement of moraines on an actual glacier composed of many tributaries.

3*d*, That the great glacier which the extension and arrangement of the Alpine debris, which constitute the erratic basin of the Rhone, presupposes, had its head in this prodigious mass of the Pennine Alps and Mont Rosa, the most elevated, most extensive, and richest in snowy peaks and profound valleys—in a word, the most colossal of all those which convey their tribute to the valley of the Rhone; a vast receptacle of eternal snow and ice, which, even in the present day, knows no rival among the Alps; insomuch that the whole of Haut Valais, on the one hand, and the valleys which descend from Mont Blanc on the other, act simply as its affluents.

Thus we explain the grouping of the species of rocks in parallel and linear zones, their distribution in special localities, and their respective situation, always conformable to the position of the valleys from which they have issued.

Thus, by means of the law of central or median moraines, we give an explanation of the remarkable fact, that the blocks which come from the most remote valleys and the most elevated peaks, such as the Pennine rocks, are likewise those which, notwithstanding their often enormous size, stray the greatest distance from their primitive sites. According to this hypothesis, the preservation of the blocks, their angular forms, or striated surfaces, their passage across lakes, their elevated position on the sides of mountains, for which no other hypothesis gives any probable account—in a word, the erratic phenomena—are no longer in our eyes an impenetrable mystery.

Latitudinal Distribution of Reptiles inhabiting the Malayan Peninsula and Islands, and other localities. By THEODORE CANTOR, M.D., Bengal Medical Service.

[*Sp.* prefixed to localities signifies that they are inhabited by *species* of which varieties occur in Malayan countries.]

CHELONIA.

1. *Geoemyda spinosa*, Gray.	Pinang.	Sumatra.
2. *Emys crassicollis*, Bell, ms.	Pinang, Malayan Peninsula.	Sumatra, Java.
3. *Emys platynota*, Gray.	Pinang, Malayan Peninsula.	Sumatra.
4. *Emys trivittata*. Dum. and Bibr.	Pinang, Malayan Peninsula.	Bengal, Assam.
5. *Cistudo amboinensis* (Daud.)	Singapore, Malayan Peninsula.	Java, Amboina, Philippines, Tenasserim Provinces.
6. *Tetraonyx affinis*, Cantor.	Pinang.	
7. *Gymnopus gangeticus* (Cuv.).	Pinang, Malayan Peninsula.	Rivers and Bay of Bengal.
8. *Gymnopus cartilagineus* (Boddaert)·	Pinang, Malayan Peninsula.	Java, Dukhun, "India," "China."
9. *Gymnopus indicus*, (Gray).	Pinang, Malayan Peninsula.	Rivers of India, Philippines.

10. *Chelonia virgata*, Schweigger.	Malayan Seas.	Teneriffe, Rio Janeiro, Cape of Good Hope, New York, Indian Ocean, Red Sea.
11. *Chelonia imbricata*, (Linné).	Malayan Seas.	Atlantic and Indian Ocean.
12. *Chelonia olivacea*, Eschscholtz.	Malayan Seas.	Bay of Bengal, China Sea.

SAURIA.

1. *Crocodilus vulgaris*, Cuv. Var. B. Dum. and Bibr.	Malayan Peninsula and Islands.	Java, Sumatra, Tenasserim, Bengal, Coromandel, Malabar.
2. *Crocodilus porosus*, Schneider.	Pinang, Singapore, Malayan Peninsula.	Seychelle Islands, Timor, Java, Sumatra, Tenasserim, Bengal.
3. *Platydactylus lugubris*, Dum. and Bibr.	Pinang.	Otaheite.
4. *Platydactylus gecko* (Linné).	Malayan Peninsula.	Philippines, Java, Tenasserim, Burmah, Bengal, Coromandel.
5. *Platydactylus stentor*, Cantor	Pinang.	
6. *Platydactylus monarchus*, Schlegel.	Pinang, Singapore, Malayan Peninsula.	Philippines, Amboina, Borneo.
7. *Ptychozoon homalocephalum* (Creveld)	Pinang, Singapore.	Ramree Island (Arracan).
8. *Hemidactylus peronii*, Dum. & Bibr.	Pinang.	Isle of France.
9. *Hemidactylus coctæi*, Dum. and Bibr.	Pinang.	Bengal, Bombay.
10. *Hemidactylus frenatus*, Schlegel, ms.	Pinang, Singapore, Malayan Peninsula.	Amboina, Timor, Java, Marian Isles, Ceylon, Bengal, Assam, South Africa, Madagascar.
11. *Hemidactylus platyurus* (Schneider).	Pinang.	Philippines, Borneo, Java, Bengal, Assam.
12. *Gymnodactylus pulchellus* (Gray).	Pinang, Singapore.	
13. *Varanus nebulosus*, Dum. and Bibr.	Pinang.	Java, Siam, Bengal.
14. *Varanus flavescens* (Gray).	Pinang.	Bengal, Nipal.

15. *Varanus salvator* (Laurenti).	Pinang, Malayan Peninsula.	Philippines, Moluecas, Amboina, Java, Bengal, Assam.
16. *Bronchocela cristatella* (Kuhl).	Pinang, Singapore, Malayan Peninsula.	Amboina, Island of Buru, Java, Sumatra.
17. *Lophyrus armatus* (Gray).	Pinang, Singapore.	Cochin-China.
18. *Dilophyrus grandis* (Gray).	Pinang.	Rangoon.
19. *Draco-volans* (Linné).	Pinang, Singapore, Malayan Peninsula.	Philippines, Borneo, Java.
20. *Draco maculatus* (Gray).	Pinang.	Tenasserim.
21. *Leiolepis bellii* (Gray).	Pinang, Malayan Peninsula.	Cochin-China,
22. *Eumeces punctatis* (Linné) *Var.*	Pinang, Singapore, Malayan Peninsula.	*Sp.* Coromandel, Malabar, Bengal.
23. *Euprepis rufescens* (Shaw). *Var. D.* Dum. and Bibr. *Var. E.* Dum. and Bibr. *Var. F.* Dum. and Bibr.	Pinang, Singapore, Malayan Peninsula.	*Sp.* Sandwich Islands, Philippines, Timor, Celebes, Borneo, Java, Coromandel, Bengal.
24. *Euprepis ernestii,* Dum. and Bibr.	Pinang, Malayan Peninsula.	Java,
25. *Lygosoma chalcides* (Linné).	Pinang, Singapore.	Java.

OPHIDIA.

Innocuous.

1. *Pilidion lineatum,* (Boie.)	Pinang, Singapore.	Java.
2. *Typhlops nigro-albus,* Dum. and Bibr.	Pinang, Singapore.	Sumatra.
3. *Typhlops braminus* (Daudin).	Pinang, Singapore, Malayan Peninsula.	Canton Province, Philippines, Guam (Marian Isles), Java, Tenasserim, Bengal, Assam, Coromandel, Ceylon, Malabar.

4. *Cylindrophis rufus* (Laurenti).	Singapore.	Java, Tranquebar, Bengal?
5. *Xenopeltis unicolor*, Reinwardt.	Pinang, Singapore, Malayan Peninsula.	Celebes, Java, Sumatra.
6. *Python reticulatus* (Schneider).	Malayan Peninsula and Islands.	Chusan? Amboina, Java, Banka, Sumatra, Bengal?
7. *Acrochordus javanicus*, Hornstedt.	Pinang, Singapore.	Java.
8. *Acrochordus granulatus* (Schneider).	Rivers and Sea of the Malayan Peninsula and Islands.	Bay of Manilla, New Guinea, Timor, Java, Sumatra, Coromandel.
9. *Calamaria lumbricoidea*, Schlegel, *Var.*	Pinang, Singapore.	*Sp.* Celebes, Java.
10. *Calamaria linnei*, Boie, *Var.* Schlegel.	Pinang.	Java.
11. *Calamaria longiceps*, Cantor.	Penang.	
12. *Calamaria sagittaria*, Cantor.	Malayan Peninsula.	Bengal, Assam.
13. *Coronella baliodeira*, Schlegel.	Pinang.	Java.
14. *Xenodon purpurascens*, Schlegel.	Pinang.	Java, Tenasserim. *Var.* Chirra Punji, Assam, Darjeling, Midnapore (Bengal).
15. *Lycodon aulicus* (Linné).	Pinang.	Bengal, Coromandel.
Var. A.	Pinang.	Bengal.
Var. B.	Pinang, Malayan Peninsula.	Java, Tenasserim.
Var. C.	Pinang, Malayan Peninsula.	Pulo Samao, Timor.
Var. D.	Malayan Peninsula.	Bengal.
16. *Lycodon platurinus* (Shaw).	Pinang.	Java, Bengal?
17. *Lycodon effrænis*, Cantor.	Pinang.	
18. *Coluber fasciolatus*, Shaw.	Malayan Peninsula.	Coromandel.

19. *Coluber radiatus*, Schlegel.	Pinang, Singapore, Malayan Peninsula.	Java, Sumatra, Cochin-China, Tenasserim, Assam.
20. *Coluber korros*, Reinwardt.	Pinang, Singapore, Malayan Peninsula.	Java, Sumatra, Arracan, Tenasserim.
21. *Coluber hexagonotus*, Cantor.	Pinang.	
22. *Dipsas dendrophila*, Reinwardt.	Pinang, Singapore, Malayan Peninsula.	Celebes, Java.
23. *Dipsas multimaculata*, Schlegel.	Pinang, Malayan Peninsula.	Celebes, Java, Tenasserim, Bengal.
24. *Dipsas cynodon*, Cuvier.	Pinang, Malayan Peninsula.	Java, Tenasserim.
25. *Dipsas boa*, Boie.	Pinang.	Java.
26. *Herpetodryas oxycephalus* (Reinwardt).	Pinang.	Celebes.
27. *Dryinus prasinus* (Reinwardt).	Malayan Peninsula and Islands.	Celebes, Java, Cochin-China, Siam, Burmah, Tenasserim, Arracan, Bengal, Assam.
Var. A.	Same localities.	Same localities.
Var. B.	Pinang.	
Var. C.	Pinang.	
28. *Leptophis pictus* (Gmelin).	Malayan Peninsula and Islands.	Manilla, New Ireland, Waigiou, Amboina, New Guinea, Pulo Samao, Java, Sumatra, Cochin-China, Tenasserim, Burmah, Bengal, Assam, Coromandel.
Var. A.	Malayan Peninsula.	Bengal, Assam, Ceylon.
29. *Leptophis caudalineatus*, Cantor.	Pinang, Singapore.	
30. *Letophis ornatus* (Shaw).		*Sp.* Bengal, Ceylon.
Var.	Pinang, Malayan Peninsula.	Java, Sumatra, Tenasserim, Arracan.
31. *Tropidonotus umbratus* (Daudin).		*Sp.* Bengal, Assam, Coromandel, Ceylon.
Var.	Malayan Peninsula and Islands.	Java, Bengal.

32. *Tropidonotus stolatus* (Linné).	Pinang, Malayan Peninsula.	Philippines, Tenasserim, Bengal, Assam, Nipal, Coromandel, Ceylon, Bombay.
33. *Tropidonotus schistosus* (Daudin).	Malayan Peninsula.	Philippines, Tenasserim, Bengal, Madagascar.
Var.	Same locality.	Same localities.
34. *Tropidonotus cerasogaster* (Cantor).	Malayan Peninsula.	Bengal, Assam.
35. *Tropidonotus junceus*, Cant.	Pinang.	
36. *Homalopsis rhinchops* (Schneider).	Malayan Peninsula and Islands.	New Guinea, Amboina, Timor, Sarapua, Java, Sumatra, Tenasserim, Bengal, Coromandel.
37. *Homalopsis buccata* (Linné).	Pinang, Malayan Peninsula.	Java.
38. *Homalopsis Sieboldi*, Schlegel.	Malayan Peninsula.	Bengal.
39. *Homalopsis enhydris* (Schneider).	Malayan Peninsula and Islands.	Java, Tenasserim, Bengal, Coromandel.
40. *Homalopsis plumbea*, Boie.	Pinang.	Java.
41. *Homalopsis leucobalia*, Schlegel, *Var.*	Pinang, Malayan Peninsula.	*Sp.* Timor.
42. *Homalopsis hydrina*, Cantor.	Sea off Pinang, and the Malayan Peninsula.	
	Venomous.	
43. I. *Elaps melanurus* (Shaw).	Malayan Peninsula.	Tenasserim, Nerva (Coromandel).
44. II. *Elaps intestinalis* (Laurenti). *Var.*	Pinang, Singapore, Malayan Peninsula.	*Sp.* Java, Malwah (Central India).
45. III. *Elaps nigromaculatus*, Cantor.	Pinang, Singapore.	
46. IV. *Elaps bivirgatus*, Kuhl, *Var.*	Pinang, Malayan Peninsula.	*Sp.* Java, Sumatra.
47. V. *Bungarus flaviceps*, J. Reinhardt.	Pinang.	Java.
48. VI. *Bungarus candidus*, (Linné).	Malayan Peninsula.	Java, Tenasserim, Bengal, Assam, Coromandel, Ceylon, Malabar.

49. VII. *Bungarus fasciatus* (Schneider).	Pinang, Malayan Peninsula.	Java, Tenasserim, Bengal, Coromandel.
50. VIII. *Hamadryas ophiophagus*, Cantor.	Pinang, Singapore, Malayan Peninsula.	Java, Sumatra, Bengal, Assam, Coromandel.
51. IX. *Naja lutescens*, Laurenti.		*Sp.* Countries between the Sutlej and Cape Comorin, Ceylon, Hindoostan to Cape Romania, Sumatra, Java, Ternate, Borneo, Philippines, Chusan.
Var. D. (Daudin).	Pinang, Singapore, Malayan Peninsula.	Bengal, Coromandel.
Var. nigra,	Pinang, Singapore.	
52. X. *Trigonocephalus gramineus* (Shaw).	Pinang, Singapore, Malayan Peninsula.	New Holland, Timor, Pulo Samao, Celebes, Eastern Java, Banka, Sumatra, Tenasserim, Bengal, Chirra Punji, Nipal, Coromandel, Ceylon.
Var.	Pinang, Singapore, Malayan Peninsula.	Sumatra, Tenasserim.
53. XI. *Trigonocephalus sumatranus* (Raffles) *Var.*	Pinang, Singapore, Malayan Peninsula.	*Sp.* Sumatra.
54. XII. *Trigonocephalus puniceus*, Reinwardt.	Pinang, Singapore, Malayan Peninsula.	Java.
55. XIII. *Laticauda scutata*, Laurenti.	Sea of the Malayan Peninsula and Islands.	Bay of Bengal, Sea of Timor, Celebes, Molucca, and Liewkiew Islands, New Guinea, Tongataboo, China Sea.
56. XIV. *Hydrus striatus* (Lacépède).	Sea of Pinang, Malayan Peninsula.	Sea of Liewkiew Islands, Timor, Sumatra, Bay of Bengal.
57. XV. *Hydrus nigrocinctus* (Daudin).	Sea of Pinang, Singapore, Malayan Peninsula.	Bay of Bengal, estuaries of the Ganges.
Var. ?	Sea off Pinang.	

58. XVI. *Hydrus gracilis*, Shaw.	Sea of Malayan Peninsula and Island.	Bay of Bengal, Malabar, Sumatra, Borneo.
59. XVII. *Hydrus schistosus* (Daudin).	Sea of Malayan Peninsula and Islands.	Bay of Bengal, Malabar, Sumatra.
60. XVIII. *Hydrus pelamidoides* (Schlegel).	Sea of Malayan Peninsula and Islands.	Bay of Bengal, Sea of Celebes, Molucca Islands, China Sea.
61. XIX. *Hydrus bicolor* (Schneider).	Sea of Malayan Peninsula.	Bay of Bengal, Sea of Sumatra, Java, Celebes, Moluccas, China Sea (to 27° N. L.) Otaheite, Bay of Port Jackson (33° 55′ S. L. 151° 25′ E. L.)

BATRACHIA.

1. *Ichthyophis glutinosus* (Linné.) *Var.?*	Singapore.	*Sp.* Java, Ceylon, Assam.
2. *Rana leschenaulti*, Dum. and Bibr.	Malayan Peninsula.	Bengal, Pondicherry.
3. *Rana tigrina*, Daudin.	Malayan Peninsula and Islands.	Coromandel, Bengal, Assam, Tenasserim, Java, Sumatra, Timor, Philippines, Canton Province.
4. *Megalophrys montana*, Wagler, *Var.*	Pinang.	*Sp.* Java.
5. *Limnodytes erythræus*, (Schlegel).	Malayan Peninsula.	Java, Tenasserim, Arracan.
6. *Polypedates leucomystax*, (Gravenhorst).	Pinang, Singapore, Malayan Peninsula.	Bengal, Coromandel, Malabar.
7. *Bufo melanostictus*, Schneider.	Malayan Peninsula and Islands.	Java, Tenasserim, Bengal, Coromandel.
8. *Hylædactylus bivittatus*, Cantor.	Malayan Peninsula.	

Altitudinal Distribution of Reptiles inhabiting the Malayan Peninsula and Islands, and other localities.

[The extra-Malayan localities have necessarily been confined to such of which the elevation has been specified by authors, the Malayan are given from personal observation.]

Prince of Wales Island (Pulo Pinang), 5° 25′ N. L., 100° 19′ E. *Valley*: Mean annual temperature, 80°·03 Fahr. Average monthly range of the thermometer, 11°; greatest daily range, 13°. Annual quantity of rain 55·5 inch. (145 days.)

Hills: Granite. Highest elevation (*Western Hill*), 2500 ft. Mean annual temperature 71°. Average monthly range of the thermometer 10°; greatest daily range, 9°. Annual quantity of rain, 116·6 inch (174 days.) Vegetation, even for a tropical, distinguished by luxuriance, beauty, and variety. Characteristic features: Filices. (*Alsophila contaminans*, Wal.—*Schizœa dichotoma*,—*Neuroplatyceros* (*Acrostichum*) *biforme*, Desvontaine. *Polypodium Horsfieldii*, Bennett.)

Pandanaceæ. (*Freycinetia.*)

Taccaceæ. (*Tacca cristata*, Jack.)

Palmaceæ. (*Areca catechu*, Willd. *Arenga saccharifera*, Labill. *Nipa fruticans*. *Euoplus tigillaria*, Jack. "*Pinang Lawyer.*"* *Calamus.*)

Scitamineæ. (*Hedychium sumatranum*, Jack. *Amomum biflorum*, Jack).

Orchidaceæ.

Taxaceæ. (*Dacrydium*. *Podocarpus.*)

Gnetaceæ. (*Gnetum gnemon*. *Gnetum brunonianum.*)

Artocarpeæ. (*Phytocrene palmata*, Wal. *Phytocrene bracteata*,† Wal.)

Nepenthaceæ. (*Nepenthes distillatoria*. *Nepenthes ampullaria*, Jack.)

Gesneraceæ. (*Didymocarpus crinitus*, Jack.)

Euphorbiaceæ.

Corylaceæ. (*Quercus racemosa*, Jack. *Lithocarpus javensis*, Blume.)

Begoniaceæ. (*Begonia orbiculata*, Jack.)

Sterculiaceæ. (*Sterculia coccinea*, Roxburgh. *Durio Zibethinus*, Lin.)

Dipteraceæ. (*Dipterocarpus.*)

Aurantiaceæ. (*Murraya puniculata*, Loar.)

Anacardiaceæ. (*Stagmaria verniciflua*, Jack.)

Connaraceæ. (*Eurycoma longifolia*, Jack.)

Garcinieæ.

Melastomaceæ. (*Melastoma bracteata*, Jack. *M. exigua*, Jack. *M. glauca*, Jack. *Sonerila moluccana*, Rob.)

Myrtaceæ.

Singapore Island, 1° 24′ N. L., 104° E. Mean annual temperature, 80°. Greatest daily range of theremometer, 10°. Annual number of rainy days, 185. Surface gently undulating. Sandstone hills, indicating remote convulsion; highest hill (*Bukit Timah*) 530 ft. In the valleys occur vegetable and animal forms, which at Pinang have been observed at or near the summit of the hills, but not in the plains. Thus at Singapore, occur *Alsophila*, *Schizœa*, *Tacca cristata*, *Gnetum*, *Nepenthes*, *Begonia*, *Eurycoma*, and others, which at Pinang appear to affect a much greater elevation. Instances of Reptiles in common to the plains of Singapore and the hills of Pinang are, *Ptychozoon homalocephalum*,

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* An undescribed dwarf palm, hitherto supposed to be confined to the hills of Pinang. Sir William Norris found it on Mount Ophir in 1847.

† This species appears to be confined to the lower part of the hills and the valleys.

Gymnodactylus pulchellus, Lygosoma chalcides, Pilidion lineatum, Typhlops nigroalbus, Calamaria lumbricoidea. Var. Leptophis caudalineatus, Elaps intestinalis, Elaps nigromaculatus.

Malayan Peninsula. Geographically, not politically, from 12° N. L. between 98° and 104° E., computed to be about 80,000 square miles, or about 4000 square miles less than Great Britain, zoological information has hitherto been confined almost exclusively to the plains of the western part. The productions of the chain of mountains dividing the Peninsula, and terminating in Cape Romania in 1° 17′ N. L. (Point Búrus in 1° 15′ N. L.) are almost entirely unknown. The late Mr Griffith on a visit in the early part of 1842 to mount Ophir (*Gúnong Ledang*, in about 2° 30′ N. L. on the eastern boundary of the district of Malacca granite, and computed about 4000 ft.) made the interesting discovery, that from 1500 ft. and upwards, the vegetation changes completely, and in many respects assumes a Polynesian or Australian character. Early in 1847 Lieutenant-Colonel James Low visited Keddah Peak (*Gúnong Jerai*), opposite to the town of Keddah, in about 6° 5′ N. L., which he observes is not granite, but stratified, abounding in minerals. According to observation of the boiling point of water, the summit, a small platform on the edge of the strata, is 5705½ feet above the sea. Towards the summit the vegetation becomes very stunted, and partakes of Australian character.* Colonel Low further observes, that during the ascent, he did not see a single animal, but found foot-prints of a Rhinoceros, smaller than usual, he supposes, up to the very summit. To a casual visiter of the Malayan hill forest, during the day, the paucity of animals is a striking feature. The noonday light, subdued by the dense foliage of the towering stems, gives to the scene a sombre character, heightened by the unseen denizens. Their presence is manifested in the shrill vibrations of Cicadæ, one of which on the Pinang hills is noted for its resemblance to the cavalry trumpet, the call of the Tupai, the dismal tap of the gigantic wood-pecker, the creaking flight of a Buceros, or the retreat of frightened Semnopithecs.

CHELONIA.

SPECIES.	HILLS.	PLAINS.
Geoemyda spinosa, Gray.	Pinang.	
Emys crassicollis, Bell, MS.		Ponds and rivulets Malayan Peninsula, Pinang.
Emys platynota, Gray.		Malayan Peninsula, Pinang.
Emys trivittata, Dum. & Bibr.		Ponds and rivers Malayan Peninsula, Pinang, Bengal.

* A collection of plants from the summit of the mountain, with which Colonel Low favoured me, were examined by Captain Munro, H.M. 39th Regiment, the only botanist at present in Calcutta, previously to their being despatched to the Royal Gardens, Kew.

SPECIES.	HILLS.	PLAINS.
Cistudo amboinensis, (Daud).		Ditto, ditto.
Tetraonyx affinis, Cantor.		Sea off Pinang.
Gymnopus gangeticus, (Cuvier).		Rivers and sea-coast Malayan Peninsula, Bengal.
Gymnopus cartilagineus, (Boddaert).		Ponds and rivers, Malayan Peninsula, Pinang, Java, Dukhun, "India," "China."
Gymnopus indicus, (Gray).		Rivers, estuaries, and sea-coast, Malayan Peninsula, Pinang, India, Philippine Islands.
Chelonia virgata, Schw.		Sea.
Chelonia imbricata (Lin).		Sea.
Chelonia olivacea, Eschscholtz.		Sea.
	SAURIA.	
Crocodilus vulgaris, Cuv. *Var. B.* Dum., and Bibr.		Rivers, estuaries and sea-coast, Malayan Peninsula and Islands, Java, Sumatra, Tenasserim, Bengal, Coromandel, Malabar.
Crocodilus porosus, Schneider.		Ditto, ditto, and Seychelle Islands, Timor.
Platydactylus lugubris, Dum. and Bibr.		Pinang.
Platydactylus gecko, (Linn´).		Malayan Peninsula, Bengal.
Platydactylus stentor, Cantor.	Pinang.	
Platydactylus monarchus, Schlegel.	Pinang.	Pinang, Malayan Peninsula, Singapore.
Ptychozoon homalocephalum, (Creveld).	Pinang.	Singapore.
Hemidactylus peronii, Dum. and Bibr.		Pinang.
Hemidactylus coctæi, Dum. and Bibr.		Pinang, Bengal.
Hemidactylus frenatus, Schlegel, MS.	Pinang.	Pinang, Singapore, Malayan Peninsula, Bengal.

SPECIES.	HILLS.	PLAINS.
Hemidactylus platyurus, (Schneider).		Pinang, Bengal.
Gymnodactylus pulchellus, (Gray).	Pinang.	Singapore.
Varanus nebulosus, Dum. and Bibr.	Pinang.	Bengal.
Varanus flavescens, (Gray).		Pinang, Bengal.
Varanus salvator, (Laurenti).	Pinang.	Malayan Peninsula, Bengal.
Bronchocela cristatella, (Kuhl).	Pinang, Malayan Peninsula.	Malayan Peninsula, Singapore.
Lophyrus armatus, (Gray).		Pinang, Singapore.
Dilophyrus grandis, Gray.	Pinang.	
Draco volans, Linné.	Pinang.	Pinang, Malayan Peninsula.
Draco maculatus, (Gray).	Pinang.	
Leiolepis bellii, (Gray).		Pinang, Malayan Peninsula.
Eumeces punctatus (Lin). *Var.*	Pinang.	Pinang, Malayan Peninsula, Singapore.
Euprepis, rufescens, (Shaw).		
Var. D. Dum. and Bibr. *Var. E.* Dum. and Bibr. *Var. F.* Dum. and Bibr.	Pinang.	Pinang, Malayan Peninsula, Singapore.
Euprepis ernestii, Dum. and Bibr.		Pinang, Malayan Peninsula.
Lygosoma chalcides, (Linné).	Pinang.	Singapore.

OPHIDIA.

INNOCUOUS.

Pilidion lineatum, (Boie).	Pinang.	Singapore.
Typhlops nigro-albus, Dum. and Bibr.	Pinang.	Singapore.

SPECIES.	HILLS.	PLAINS.
Typhlops braminus, (Daudin).	Pinang, Malayan Peninsula.	Pinang, Singapore, Malayan Peninsula, Bengal, Assam.
Cylindrophis rufus, (Laurenti).		Singapore, Tranqubar, Bengal.
Xenopeltis unicolor, Reinwardt.	Pinang.	Singapore, Malayan Peninsula.
Python reticulatus, (Schneider).	Pinang, Malayan Peninsula.	Pinang, Singapore, Malayan Peninsula, Bengal?
Acrochordus javanicus, Hornstedt.	Pinang.	Singapore, Java.
Acrochordus granulatus, (Schneider).		Rivers and sea-coast of Malayan Peninsula and Islands, New Guinea, Timor, Java, Sumatra, Coromandel, Bay of Manilla.
Calamaria lumbricoidea Schlegel, *Var.*	Pinang.	Singapore.
Calamaria linnei, Boei, *Var*, Schlegel.	Pinang.	Java.
Calamaria longiceps, Cantor.	Pinang.	
Calamaria sagittaria, Cantor.		Malayan Peninsula, Bengal.
Coronella baliodeira Schlegel.	Pinang.	
Xenodon purpurascens, Schlegel.	Pinang.	Java.
Lycodon aulicus (Linné).	Pinang.	Pinang, Malayan Peninsula, Bengal.
Var. A.	Pinang.	Pinang, Bengal.
Var. B.	Pinang.	Pinang, Malayan Peninsula.
Var. C.	Pinang, Malayan Peninsula.	Pinang, Malayan Peninsula.
Var. D.		Malayan, Peninsula, Bengal.
Lycodon platurinus (Shaw).	Pinang.	Bengal?
Lycodon effrænis, Cantor.	Pinang.	
Coluber fasciolatus, Shaw.		Malayan Peninsula, Coromandel.

Species.	Hills.	Plains.
Coluber radiatus, Schlegel.		Pinang, Singapore, Malayan Peninsula.
Coluber korros, Reinwardt.		Pinang, Singapore, Malayan Peninsula.
Coluber hexagonotus, Cantor.	Pinang.	
Dipsas dendrophila, Reinwardt.	Pinang, Malayan Peninsula.	Pinang, Singapore, Malayan Peninsula, Java.
Dipsas multimaculata, Schlegel.	Pinang.	Malayan Peninsula.
Dipsas cynodon, Cuvier.	Pinang.	Malayan Peninsula.
Dipsas boa, Boie.	Pinang.	Java.
Herpetodryas oxycephalus (Reinwardt).	Pinang.	
Dryinus prasinus (Reinwardt).	Malayan Peninsula and Islands.	Malayan Peninsula and Islands.
Var. A.	Ditto.	Ditto.
Var. B.	Pinang.	
Var. C.	Pinang.	
Leptophis pictus (Gmelin).	Malayan Peninsula and Islands.	Malayan Peninsula and Islands, Bengal.
Var. A.	Ditto.	Ditto.
Leptophis caudalineatus, Cantor.	Pinang.	Singapore.
Leptophis ornatus (Shaw), *Var.*	Pinang.	Malayan Peninsula.
Tropidonotus umbratus (Daud.), *Var.*		Malayan Peninsula and Islands, Java, Bengal.
Tropidonotus stolatus (Linné).		Pinang, Malayan, Peninsula, Bengal, Nipal, Coromandel, Bombay.
Tropidonotus schistosus (Daud.).		Malayan Peninsula, Bengal.
Var.		Ditto, ditto.
Tropidonotus cerasogaster (Cantor).		Malayan Peninsula, Bengal.
Tropidonotus junceus, Cantor.	Pinang.	
Homalopsis.		All the Malayan species inhabit fresh water rivers, estuaries, or the sea-coast, as noted under each.

VENOMOUS.

SPECIES.	HILLS.	PLAINS.
Elaps melanurus (Shaw).		Malayan Peninsula, Tenasserim, Nerva.
Elaps intestinalis Laurenti), *Var.*	Pinang.	Singapore, Malayan Peninsula, *Sp.* Java, Malwah (Central India).
Elaps nigromaculatus, Cantor.	Pinang.	Singapore.
Elaps bivirgatus, Kuhl. *Var.*	Pinang.	Malayan Peninsula.
Bungarus flaviceps, J. Reinwardt.	Pinang.	
Bungarus candidus (Linné).		Malayan Peninsula, Bengal, Coromandel, Malabar.
Bungarus fasciatus (Schneider).		Pinang, Malayan Peninsula, Bengal, Coromandel.
Hamadryas ophiophagus, Cantor.	Pinang.	Singapore, Malayan Peninsula, Bengal.
Naja lutescens. Laurenti. *Var. D.* (Daud.).	Pinang, Malayan Peninsula.	Pinang, Singapore, Malayan Peninsula, Bengal, Coromandel.
Var. nigra.	Pinang.	Pinang, Singapore.
Trigonocephalus gramineus (Shaw).	Pinang, Malayan Peninsula, Chirra Punji.	Pinang, Singapore, Malayan Peninsula, Bengal, Nipal.
Var.	Pinang, Malayan Peninsula.	Pinang, Singapore, Malayan Peninsula.
Trigonocephalus sumatranus (Raffles), *Var.*		Pinang, Singapore, Malayan Peninsula. *Sp.* Sumatra.
Trigonocephalus puniceus, Reinwardt.		Pinang, Singapore, Malayan Peninsula.
Laticauda Hydrus.		All species inhabit the sea or estuaries.

BATRACHIA.

Ichthyophis glutinosus (Linné), *Var.*		Singapore.
Rana leschenaulti, Dum. and Bibr.		Malayan Peninsula, Bengal, Pondicherry.

Rana tigrina, Daudin.	Malayan Peninsula and Islands.	Malayan Peninsula and Islands, Bengal.
Megalophreys montana, Wagler, *Var.*	Pinang, *Sp.* Java.	
Limnodytes erythræus (Schlegel).		Malayan Peninsula.
Polypedates leucomystax (Gravenhorst).	Pinang, Malayan Peninsula.	Singapore, Malayan Peninsula, Bengal.
Bufo melanostictus, Schneider.	Malayan Peninsula and Islands.	Malayan Peninsula and Islands, Bengal.
Hylædactylus bivittatus, Cantor.		Malayan Peninsula.

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Gutta Percha. By Thomas Oxley, Esq., A.B., Senior Surgeon of the Settlement of Prince of Wales Island, Singapore, and Malacca.

Discovery of the Gutta Percha by Europeans—Botanical Description—Range, habitat, mode of procuring—Properties, uses, application to the practice of Surgery—Great superiority to bandages and splints in cases of fracture—Capsules for vaccine virus—Patents in England for cleansing the Gutta, and removing its acidity—Means of procuring it pure where it is produced.

Although the trees yielding this substance abound in our indigenous forests, it is only four years since it was discovered by Europeans. The first notice taken of it appears to have been by Dr W. Montgomerie, in a letter to the Bengal Medical Board, in the beginning of 1843, wherein he commends the substance as likely to prove useful for some surgical purposes, and supposes it to belong to the Fig tribe. In April 1843, the substance was taken to Europe by Dr D'Almeida, who presented it to the Royal Society of Arts of London, but it did not at first attract much attention, as the Society simply acknowledged the receipt of the gift; whereas shortly after they thought proper to award a gold medal to Dr W. Montgomerie for a similar service. Now, as the discovery of both of these gentlemen rested pretty much upon the same foundation—the accidental falling in with it in the hands of some Malays, who had found out its greatest peculiarity, and availed themselves thereof, manufactured it into whips, which were brought into town for sale—there does not appear any plausible reason for the passing over the first, and rewarding the second. Both gentlemen are highly to be commended for endeavouring to introduce to public notice a substance which has proved so useful and interesting. The Gutta Percha having of late attracted much attention, and as yet but little being known or published about it, I would now propose to supply, to the best of my ability, this desideratum, and give a description of the tree, its product and uses, so far as it has been made available for domestic and other purposes in the place of its origin.

The Gutta Percha tree, or Gutta Tuban, as it ought more properly be called,—the Percha producing a spurious article,—belongs to the natural family Sapoteæ, but differs so much from all described genera, having alliance with both Achras and Bassia, but differing in some essentials from both, that I am disposed to think it is entitled to rank as a new genus. I shall, therefore, endeavour to give its general character, leaving the honour of naming it to some more competent botanist, especially as I have not quite satisfied myself regarding the stamens from want of specimens, for observations.

The tree is of a large size, from 60 to 70 feet in height, and from 2 to 3 feet in diameter. Its general appearance resembles the genus Durio, or well-known Doorian, so much so as to strike the most superficial observer. The under surface of the leaf, however, is of a more reddish and decided brown than in the Durio, and the shape is somewhat different.

The flowers are axillary, from 1 to 3 in the axils, supported on short curved pedicles, and numerous along the extremities of the branches.

Calyx inferior, persistent, coriaceous, of a brown colour, divided into six sepals, which are arranged in double series.

Corolla monopetalous, hypogenous, divided like the calyx into six acuminate segments.

Stamens inserted into throat of the corolla, in a single series, variable in number, but, to the best of my observation, the normal number is twelve, most generally all fertile; anthers supported on slender bent filaments, opening by two lateral pores.

.Ovary superior, terminated by a long simple style, six-celled, each cell containing one seed.

Leaves about four inches in length, perfect, entire, of a coriaceous consistence, alternate, obovate, lanceolate; upper surface of a pale green; under surface covered with close, short, reddish-brown hairs; midrib projects a little, forming a small process or beak.

Every exertion of myself and several others have failed in procuring a specimen of the fruit of the Gutta. I regret being compelled to omit the description of it in the present instance; but hope to rectify this omission in a future number of the Journal. It is quite extraordinary how difficult it is to obtain specimens of either the flower or the fruit of this tree, and this is probably the reason of its not having been earlier recognised and described by some of the many botanists who have visited these parts.

Only a short time ago the Tuban Tree was tolerably abundant on the island of Singapore; but already all the large timber has been felled, and few, if any, other than small plants are now to be found. The range of its growth, however, appears to be considerable; it being found all up the Malayan Peninsula, as far as Pinang, where I have ascertained it to be abundant; although, as yet, the inhabitants do not seem to be aware of the fact; several of the mercantile houses there having sent down orders to Singapore for supplies of the article, when they have the means of supply close at hand. The tree is also found in Borneo, and I have little doubt is to be found in most of the islands adjacent.

The localities it particularly likes are the alluvial tracts along the foot of hills, where it flourishes luxuriantly, forming, in many spots, the principal portion of the jungle. But notwithstanding the indigenous character of the tree, its apparent abundance and wide-spread diffusion, the Gutta will soon become a very scarce article, if some more provident means be not adopted in its collection than at present in use by the Malays and Chinese.

The mode in which the natives obtain the gutta is by cutting down the trees of full growth, and ringing the bark at distances of about 12 to 18 inches apart, and placing a cocoanut shell, spathe of a palm, or such like receptacle, under the fallen trunk to receive the milky sap that immediately exudes upon every fresh incision. This sap is collected in bamboos, taken to their houses and boiled, in order to drive off the watery particles and inspissate it to the consistence it finally assumes. Although the process of boiling appears necessary when the gutta is collected in large quantity, if a tree be freshly wounded, a small quantity allowed to exude, and it be collected and moulded in the hand, it will consolidate perfectly in a few minutes, and have all the appearance of the prepared article.

When it is quite pure the colour is of a greyish-white; but as brought to market it is more ordinarily found of a reddish hue, arising from chips of bark that fall into the sap in the act of making the incisions, and which yield their colour to it. Besides these accidental chips, there is a great deal of intentional adulteration by sawdust and other materials. Some specimens I have lately seen brought to market could not have contained much less than one quarter of a pound of impurities; and even the purest specimens I could obtain for surgical purposes, one pound of the substance yielded, on being cleansed, one ounce of impurities. Fortunately, it is neither difficult to detect or clean the gutta of foreign matter, it being only necessary to boil it in water until well softened, roll out the substance into thin sheets, and then pick out all impurities, which is easily done, as the gutta does not adhere to any thing, and all foreign matter is merely entangled in its fibres, not incorporated in its substance. The quantity of gutta obtained from each tree varies from five to twenty catties, so that, taking the average at ten catties, which is a tolerably liberal one, it will require the destruction of ten trees to produce one picul. Now, the quantity exported from Singapore to Great Britain and the Continent, from 1st January 1845 to the present date, amounts to 6918 piculs, to obtain which 69,180 trees must have been sacrificed. How much better would it therefore be to adopt the method of tapping the tree practised by the Burmese in obtaining the caoutchouc from the *Ficus elastica* (viz., to make oblique incisions in the bark, placing bamboos to receive the sap which runs out freely), than to kill the goose in the manner they are at present doing. True, they would not at first get so much from a single tree, but the ultimate gain would be incalculable, particularly as the tree seems to be one of slow growth, by no means so rapid as the *Ficus elastica.* I should not be surprised, if the demand increases, and the present method of extermination be persisted in, to find a sudden cessation of the supply.

Properties of the Gutta.

This substance when fresh and pure is, as already mentioned, of a dirty white colour, and of a greasy feel, with a peculiar leathery smell. It is not affected by boiling alcohol, but dissolves readily in boiling spirits of turpentine, also in naphtha and coal-tar. A good cement for luting bottles and other purposes, is formed by boiling together equal parts of gutta, coal-tar, and resin. I am indebted for this hint to Mr Little, surgeon, and the above were his proportions. I have, however, found it necessary to put two parts of the gutta, that is one-half instead of one-third, to enable the cement to stand the heat of this climate. When required for use, it can always be made plastic by putting the pot containing it over the fire for a few minutes. The gutta itself is highly inflammable, a strip cut off takes light, and burns with a bright flame, emitting sparks, and dropping a black residuum in the manner of sealing-wax, which in its combustion it very much resembles. But the great peculiarity of this substance, and that which makes it so eminently useful for many purposes, is the effect of boiling water upon it. When immersed for a few minutes in water above 150° Fahrenheit, it becomes soft and plastic, so as to be capable of being moulded to any required shape or form, which it retains upon cooling. If a strip of it be cut off, and plunged into boiling water, it contracts in size both in length and breadth. This is a very anomalous and remarkable phenomenon, apparently opposed to all the laws of heat.

It is this plasticity when plunged into boiling water that has allowed of its being applied to so many useful purposes, and which first induced some Malays to fabricate it into whips, which were brought into town, and led to its further notice. The natives have subsequently extended their manufactures to buckets, basins, and jugs; shoes, traces, vessels for cooling wine, and several other domestic uses; but the number of patents lately taken out for the manufacture of the article in England, proves how much attention it has already attracted, and how extensively useful it is likely to become. Of all the purposes, however, to which it may be adapted, none is so valuable as its applicability to the practice of surgery. Here it becomes one of the most useful auxiliaries to that branch of the healing art, which of all is the least conjectural. Its easy plasticity and power of retaining any shape given to it when cool, at once pointed it out as suitable for the manufacture of bougies, and accordingly, my predecessor, Dr W. Montgomerie, availed himself of this, made several of the above instruments, and recommended the use of it to the Bengal Medical Board. But, like many other good hints, for want of sufficient inquiry, I fear it was disregarded. The practice, however, has been continued by me, and I find many advantages in the use of this substance. It also answers very well for the tubes of syringes which are always getting out of order in this country, when made of caoutchouc. But my late experiments have given it a much higher value, and proved it the best and easiest application ever yet discovered in the management of fractures, combining ease and comfort to the patient, and very much lessening the trouble of the surgeon. When I think of the farago of bandages and splints got rid of, the lightness and simplicity of the application, the gutta would be no trifling boon to mankind were it to be used solely for this and no other purpose. The injuries coming under my observation, wherein I have tested its utility have, as yet, only been two compound fractures of the leg, and one of the jaw. But so admirably has it not only answered, but exceeded my expectations, that I should think myself culpable in not giving the facts early publicity. Its utility in fracture of the lower jaw must at once strike any surgeon. So well does it mould itself to every sinuosity that it is more like giving the patient a new bone than a mere support. A man lately brought into hospital, who had his lower jaw broken by the kick of a horse, and which was so severe as to cause hæmorrhage from the ears, smashing the bone into several fragments, was able to eat and speak three days after the accident, and felt so well with his gutta splint, that he insisted leaving the hospital within ten days. My mode of applying this substance to fractures of the leg is as follows :—

The gutta having been previously rolled out into sheets of convenient size, and about one-fourth of an inch in thickness, is thus kept ready for use. When required, a piece of the necessary length and breadth is plunged into a tub of boiling water. The limb of the patient is then gently raised by assistants, making extension in the usual manner. The surgeon, having ascertained that the broken bone is in its place, takes the sheet of gutta out of the hot water, and allows it to cool for a couple of minutes. It is still soft and pliable as wash leather. Place it whilst in this state under the limb, and gently lower the latter down on it. The gutta is then to be brought round and moulded carefully to the whole of the back and sides of the leg, bringing the edges close together, but not uniting them. If there be any superfluous substance, it can be cut off with a scissor, leaving an open slit down the front of the leg. You have now the leg in a comfortable, soft, and smooth case, which, in ten minutes, will be stiff enough to retain any shape the surgeon may have given it, and which will also retain the bone *in situ*. Place the leg so done up on a double inclined plane, and secure it thereto by passing three of the common loop bandages around the whole ; that is, one at the top, one in the middle, and one at the lower end. Let the foot be supported by a foot-board, and a case of gutta put over the dorsum of the foot, to bear off the pressure of the small bandage generally used to secure it to the board Having done this, the surgeon need not cause his patient another twinge of pain until he thks he can use the leg, or he deems the bone sufficiently united to bear the weight of his patient. If it be a compound fracture, it will be only necessary to untie the loop bandages, separate the edges of the gutta splint to the required distance, wash and cleanse the limb without shifting any thing except the dressings, and having done so, shut it up again. The most perfect cleanliness can be maintained, as the gutta is not affected by any amount of ablution ; neither is it soiled or rendered offensive by any discharge, all which washes off as easily from the gutta case as from oil-cloth. I have had a patient where the tibia protruded through the integuments fully two inches, walking about in six weeks from the injury, with a leg as straight and well formed as ever it had been. It is quite obvious, therefore, that if it answers so well to compound, it will answer equally, if not better, for simple fractures ; and that any broken bone capable of receiving mechanical support can be supported by the gutta better than by any other contrivance. For it combines lightness and smoothness, durability, and a capability of adjustment, not possessed by any other known substance. All new experiments have to run the gauntlet of opposition, and I do not suppose that these recommendations will prove an exception to the rule. But all I ask of any surgeon is to try the experiment ere he argues on its propriety, and I feel fully convinced that all other splints and bandages will be consigned to the tomb of the Capulets. There are some other uses for which I have tried this substance, viz., as capsules for transmission of the vaccine virus, which ought to keep well when thus protected, for it is most perfectly and hermetically sealed ; but I have not had sufficient experience in this mode of using it to pronounce decidedly on its merits. I am at present trying the effects of it on ulcers, by inclosing the ulcerated limb in a case of gutta so as to exclude all atmospheric air, and, so far, the experiment promises success.

Since writing the foregoing observations, I have had an official intimation from Penang of the vaccine virus transmitted in the gutta capsules having been received in good order, and of its having succeeded most satisfactorily. I have also opened a capsule containing a vaccine crust that had been kept here for one month, and it also seems to have lost none of its efficacy, as the case inoculated has taken. This will appear the more striking when it is recollected that, to preserve the vaccine virus hitherto in Singapore, even for a few days, has been almost impossible ; that this settlement, notwithstanding every exertion on the part of both private and public practitioners, has been without the benefit of this important prophylactic for an interval sometimes of two years; and that at all times, the obtaining and transmitting this desirable remedy has been a cause of trouble and difficulty to all the medical officers I have ever met with in the Straits.

I observe in the *Mechanics' Magazine* for March 1847, a notice of several patents taken out for the working of this article, by Mr Charles Hancock, in which an elaborate process is described for cleaning the gutta, as also mention of its having a disagreeable acid smell. The gutta, when pure, is certainly slightly acid, that is, it will cause a very slight effervescence when put into a solution of soda, but is unaffected by liquor potassa. The smell, although peculiar, is neither strong nor unpleasant, so that the article experimented upon must have been exceedingly impure, and, possibly, derived a larger portion of its acidity from the admixture and fermentation of other vegetable substances. Again, it appears to me that, if the gutta be pure, the very elaborate process described as being necessary for cleaning it, is superfluous. The gutta can be obtained here in a perfectly pure state by simply boiling it in hot water until well softened, and then rolling it out into thin sheets, when, as I have before said, all foreign matter can be easily removed. I would recommend that the manufacturers at home should offer a higher price for the article if previously strained through cloth at the time of being collected, when they will receive the gutta in a state that will save them a vast deal more in trouble and expense than the trifling addition necessary to the original prime cost. —(From a very promising Periodical printed at Singapore, which we trust will be very generally encouraged, *The Journal of the Indian Archipelago and Eastern Asia*, No. 1, July 1847, p. 22.)*

* For further particulars regarding the Gutta percha, *vide* Dr Maclagan's Account in vol. xxxix., p. 238, of this Journal.

On the Use of Gutta Percha in Electrical Insulation. By MICHAEL FARDAY, F.R.S., Foreign Associate of the Academy of Sciences, &c.

Mr Farady, in an interesting letter to Mr Phillips, published in No. 214 of the Philosophical Magazine, March 1848, communicates the following curious particulars in regard to Gutta Percha, which are quite new, and of importance. "I have lately found," says Mr Farady, "gutta percha very useful in electrical experiments; and, therefore, that others may take advantage of its properties, if they have occasion, or are so inclined, give you this notice for insertion in the Philosophical Magazine. Its use depends upon the high insulating power which it possesses under ordinary conditions, and the manner in which it keeps this power in states of the atmosphere which make the surface of glass a good conductor. All gutta percha is not, however, equally good as it comes from the manufacturer's hands; but it does not seem difficult to bring into the best state. I will describe the qualities of a proper specimen, and refer to the differences afterwards. A good piece of gutta percha will insulate as well as an equal piece of shell-lac, whether it be in the form of sheet, a rod, or filament; but being tough and flexible when cold, as well as soft when hot, it will serve better than shell-lac, in many cases, where the brittleness of the latter is an inconvenience. Thus, it makes very good handles for carriers of electricity in experiments on induction, not being liable to fracture; in the form of thin band or string, it makes an excellent insulating suspender; a piece of it in sheet makes a most convenient insulating basis for anything placed on it. It forms excellent insulating plugs for the stems of gold-leaf electrometers, when they pass through sheltering tubes, and larger plugs supply good insulating feet for extemporary electrical arrangements; cylinders of it, half an inch or more in diameter, have great stiffness, and form excellent insulating pillars. In these, and in many other ways, its power as an insulator may be useful.

"Because of its good insulation, it is also an excellent substance for the excitement of negative electricity. It is hardly possible to take one of the soles sold by the shoemakers out of paper, or into the hand, without exciting it to such a degree as to open the leaves of an electrometer one or more inches; or, if it be unelectrified, the slightest passage over the hand or face, the clothes, or almost any other substance, gives it an electric state. Some of the gutta percha is sold in very thin sheets, resembling, in general appearance, oiled silk; and if a strip of this be drawn through the fingers, it is so electric as to adhere to the hand, or attract pieces of paper. The appearance is such as to suggest the making a thicker sheet of the substance into a plate electrical machine for the production of negative electricity.

"Then as to inductive action through the substance, a sheet of it is soon converted into an excellent electrophorus; or it may be coated, and used in place of a Leyden jar, or in any of the many other forms of apparatus dependent on inductive action.

"I have said, that all gutta percha is not in this electrical condition. With respect to that which is not so (and which has constituted above one-half of that which, being obtained at the shops, has passed through my hands), it has either discharged an electrometer as a piece of paper or wood would do, or it has made it collapse greatly by touching; yet has, on its removal, been followed by a full opening of the leaves again. The latter effect I have been able to trace and refer to a conducting portion within the mass, covered by a thin external non-conducting coat. When a piece which insulates well is cut, the surface exposed has a resinous lustre and a compact character that is very distinctive; whilst that which conducts has not the same degree of lustre, appears less translucent, and has more the aspect of a turbid solution solidified. I believe both moist steam-heat and water-baths are used in its preparation for commerce; and the difference of specimens depends probably upon the manner in which these are applied, and followed by the after-process of rolling between hot cylinders. However, if a portion of that which conducts be warmed in a current of hot air, as over the glass of a low gas-flame, and be stretched, doubled up, and kneaded for some time between the fingers, as if with the intention of dissipating the moisture within it, it becomes as good an insulator as the best.

"I have soaked a good piece in water for an hour nd on taking it out, wiping it, and exposing it to the air for a minute or two, found it insulate as well as ever. Another piece was soaked for four days, and then wiped and dried; at first it was found lowered in insulating power; but, after twelve hours' exposure to air, under common circumstances, it was as good as ever. I have not found that a week's exposure in a warm air cupboard, of a piece that did not insulate, made it much better: a film on the outside became non-conducting; but if two fresh surfaces were exposed by cutting, and these were brought into contact with the electrometer and the finger, the inside portion was still found to conduct.

"If the gutta percha, in either the good or the bad condition (as to electrical service), be submitted to a gradually increasing temperature, at about 350° or 380°, it gives off a considerable proportion of water; being then cooled, the substance which remains has the general properties of gutta percha, and insulates well. The original gum is probably complicated, being a mixture of several things; and whether the water has existed in the substance as a hydrate, or is the result of a deeper change of one part or another of the gum, I am not prepared to say. All I desire, in this note, is to make known its use in the arrangement of extemporary or permanent electrical apparatus for the advantage of working philosophers, both juvenile and adult."

Communications respecting Scandinavia. In a letter from HERR KARL BRUNER Jun., to Professor STUDER.

On the 1st of December 1845, says Prof. Studer, Herr Bruner wrote me from Berlin the following amongst other matters:—

Having arrived from my northern tour, it is not only my duty, but I have also great pleasure, in giving you an answer to the letter which I had received shortly before my departure.

On the Metamorphoses of Rocks.

You call Norway the classic land for metamorphoses of rocks. It is so, inasmuch as this theory in its present form was first put forth there : but any other mountainous region offers just as good opportunity for evolving these views. In the Alps, for instance, does not every step lead to changes which the rocks have undergone? "The same stamp," says our great master, "is impressed upon nature from the Alps as far as the North Pole. Her laws are extended universally over the surface of the earth."

The advantage which Norway affords for the study of the relations of rocks, consists in the severity of its climate permitting the growth of no luxuriant vegetation, which is so inimical to geognosy. To this is added the circumstance, that no high hills have to be climbed in order to trace the geognostical relations, and in fine, that the capital of the country, Christiania, lies exactly in the middle of that rich region.

Professor Keilhau, of Christiania, treats of the geology of his country according to the metamorphic theory.* It would almost appear to me as if he went too far in his complete rejection of chemistry and physics. For by this he plainly damages his own cause, first, by rejecting the aid of all those who steadily adhere to the positive (principle) in science ; and also, by depriving himself of many fine explanations ; for only by the aid of chemistry it appears shewn that alum-slate, which plays such a considerable part in the geology of Norway, furnishes the material of gneiss, since it has the same chemical composition ; and in Natural Philosophy alone can we hope to find an explanation for the new arrangement of molecules in the crystalline limestone of Gjellenbäk, which at the same time contains petrifactions.

It is indeed a peculiar phenomenon, that everywhere in which the unaltered transition rocks come in contact with the gneiss, the former consists of alum-slate, which, in

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* Professor Keilhau's celebrated Memoirs on Metamorphic Rocks were first published in this country in the 23d and 25th volumes of the Edinburgh New Philosophical Journal, and under the immediate superintendence of the celebrated Anthor.

the immediate neighbourhood of crystalline mountains seems to have lost all stratification; but which, on the other hand, frequently presents a cleavage parallel with the surface of the contiguous gneiss. It is this very same phenomenon which one so often meets with in our Alps, and which may increase the difficulty of the answer to the question, whether the slate character of the crystalline rock corresponds to a former state of stratification ? I have a very lively recollection of that excursion across the glacier of the Grindelwald, which I had the pleasure of making in your company. We saw that the limestone on the front of the Mettenberg exhibited a distinct and almost horizontal stratification. We then observed how gradually towards the posterior part, along the glacier, the stratification disappeared; and in place of it on the south side of the mountain, where the glacier of the Grindelwald joins the Mer de Glace, and the gneiss appears, a nearly perpendicular and very distinct separation in the limestone, running parallel with the surface of the gneiss, becomes apparent. This proves, however, that at the change of these formations, the effect of the rock-metamorphoses had extended, although in a slight degree, to the surrounding parts; and, on the other hand, that the separation of strata in limestone is a phenomenon which is first and most easily lost by external agency.

In the alum-slate of the neighbourhood of Christiania there is to be found beds of greenstone and eurite, which appear as veins wherever the stratification of the alum-slate is intersected by tabular masses of greenstone. I lately mentioned to you in a former letter, that among the transition rocks in the Hartz mountains also, greenstone appears to occur more frequently in beds than in the shape of veins. If in a mountainous region, we suppose alternate layers of different characters, of which the one kind are more susceptible of metamorphoses than the other, then we shall see the former assume the crystalline structure, while the latter retain their original character: thus we shall have the appearance of beds of crystalline formation in the midst of unchanged rock. But such changes of a rock in the midst of others that remain unchanged, is, of course, to be accounted for by no external agency, occasioned by volcanic rocks, for this would have produced like metamorphoses in all the rocks, instead of leaving the fossiliferous slates, in which those metamorphic rocks lie, in their original condition. Thus, Nature here gives us a hint that the cause of these metamorphoses could not have been produced by *external* agency. But this does not exclude the existence of the vein-genous appearance of crystalline rocks, which also occur in Norway. Certainly a state of softness has frequently arisen during those changes, especially in all those which have produced the granular crystalline rocks. Were there now such a mass in the act of metamorphoses, under great pressure, we should see the mass penetrating through fissures into the superincumbent and subjacent rock, and thus we should have veins running upwards as well as downwards. In Norway we meet with some of the latter kind, as for instance the rhombic porphyry, which, issuing from the mass of porphyry lying above the sandstone, ramify into the subjacent transition rock.

Greenstone and eurite* are consequently very abundant in the transition rock district of Christiania. A very peculiar appearance occurs about half a Norway mile north of the town. Here, in a dark-green mass of rock, appear angular fragments of granite, and various kinds of gneiss and hornblende, intermingled without the slightest order. I have brought specimens, in which we see all these varieties of rock together. I confess that I doubted the possibility of an explanation. The Vulcanists, however, are at once ready with one. They say, the greenstone has, during its upward pressure, torn off fragments from the mountain whilst piercing through it; and they make these different kinds of rock meet together in the unexplored lower regions, and there produce the formation. When I examined the rock more closely, it appeared to me as if the heterogeneous enclosures, instead of being parts of a breccia, were rather the remains of a conglomerate, which had become partly affected by the greenstone, so that only isolated hard grains which resisted the influence were left behind, and are now, of course, deprived of their former rounded form. I anticipate much pleasure

* Eurite is a very fine, granular, nearly compact, granitic mixture, with predominating felspar. With imbedded small crystals of felspar it forms eurite-porphry.

in exhibiting these fragments to you on my return, and in being able to hear your opinion regarding them. The possibility of this mode of their origin was increased in my mind to probability, when subsequently, in the crystalline slate-hills of Dovre-Fjeld and in the Kjölen, I found a similar conglomerate where the inclosures are less affected by the surrounding mass, so that one can more distinctly discern their rounded form. The boulders here also are gneiss of various appearance, and the rocky bed in which they lie is a talcose mica-slate. It is a species of *Valorsine conglomerate.* Nearer Sneehätten these slates assume the character of hornblende; and in the same ratio as they do so the conglomerates also appear. Indeed, we still see very distinctly, by their angular remains, that they once existed here also; but the appearance of the hornblende gave the signal for their destruction, and thus produced a rock which may be considered as analogous to the diorite of Christiania. If, for instance, a metamorphosis should seize our Nagelfluh, it would first assume the character of the conglomerate of Dovre-Fjeld, viz., rounded boulder stones in a crystalline ground of rock. If the metamorphosis should proceed further, then the limestone and small pebbles, for example, would disappear, and at last there would remain behind only granite and gabbro-boulders, which offer the greatest resistance; yet these also would partly dissolve, and thus lose their rounded form. In short, we would have the rock of Christiania.

The granular limestone of Gjellebäk presents the phenomenon of Monzon; but here, in Norway, beside tremolite, idocrase, garnet, and blende, there are very distinct traces of petrifactions, the very same as occur in the transition rocks of this country. In like manner, the strata of marl among limestone still remain pure; and this proves, that the metamorphic process has been easy and gradual, and that it was not a destructive granite, which, by its heat, melted the mountain to a fluid mass, out of which a new rock, the granular limestone, was crystallised. The gradual change of form of a body which still continues solid, is a problem at which many are confounded, because they cannot imitate the great experiment of nature. On a grand scale, it does not hold; but in a smaller way, the barley-sugar, which, in course of time, becomes crystalline and dull, presents an example of a change of structure without any alteration of its solidity; and copper coins, buried in the earth, become oxidised without losing their impressions.

From the Tyri-Fjord, out of which the Drammen-Elv or river discharges itself into the sea, we observe, to the south-east, a long wall of rock, which borders the beautiful district of Ringrige. In the bottom of the valley is transition rock, with its petrifactions or fossils; and above it there lies, almost horizontally, the red non-fossiliferous sandstone, which we consider as analogous to the old red. We now advance on the Krokskleven by that steep wall, and we are not a little surprised to see, lying in the middle of the declivity of the sandstone, the most beautiful porphyry, with large crystals of feldspath: it is Buch's rhombic-porphyry. That this porphyry is spread over the sandstone cannot be doubted, for it is quite horizontal, and the bounding surface of these two different rocks does not lie concealed under rubbish, but is visible along the rocky wall, and so plain, that no profile could delineate it better. One can place his hand upon it, and the evidence of the senses must be believed. The marls of the sandstone get white spots next the boundary, and frequently become amygdaloidal. I here called to remembrance the road from Castelruth up to the Seisseralp; for if one looks, for instance, in Buch's profile of that part of Tyrol, at the front side alone, and leaves out the portion which represents the interior of the Seisseralp (which also has never been observed),—as you state in your lectures,—then we have a phenomenon analogous to the Krokskleven, viz., Melaphyr, lying above marl and limestone. As everything in Norway bears a grand character, so also here this overlying of the porphyry upon the sandstone is not confined to a single locality, but, for the distance of many miles, we see in the mountains the porphyry covering the sandstone. But nobody has yet observed anything like veins passing out of the porphyry into the sandstone below; and as the porphyry is, in this case, entirely cut off from the lower regions, so, in like manner, is any explanation of this phenomenon, by the Vulcanic theory, cut off.

The Slosberg in Hadeland, as Keilhau has already described it, shews a distinct transition of clay-slate into syenite. I have collected a complete series of fossiliferous slates, in which, first, iron-pyrites lie separate on the surface, then individual crystals of hornblende, then mica, which passes into mica-slate, and even into massive syenite. It will be interesting to compare the phenomenon, which here lies so plain before our eyes, with our similar Alpine phenomena.

The true high lands of Scandinavia, which are by no means those forming the boundary between Norway and Sweden, but which lie in the western part of Norway, are not all rich in geognostic relations, for they consist entirely of gneiss and mica-slate, which, apart from interesting individual formations, which they comprise, bear the same character as everywhere else. But this extensive distribution of that rock is in itself a subject of the greatest interest; in an extent of many hundred square miles, there is nowhere to be found a single formation which, according to the modern terminology, one might venture to call granite; and, consequently, in the language of the Vulcanists, there is no cause for producing metamorphoses of rock; yet, nevertheless, every part appears crystalline, even the highest peaks, the Skagastlstinderne in Fortun-Fjeld, form no exception.

The great beds of chrome iron-ore in Trondhjem's stift lie in serpentine, and the latter forms beds in mica-slate. The appearance of serpentine in beds, which you long ago shewed in regard to the Alps, unquestionably occurs here in Norway. Veins of a white fossil carbonate, which, according to Stromeyer's analysis, is bitter-spar, ramify through the chrome iron-ore, which seems to occur in vast nests. This may appear strange, as, in general, carbonate of magnesia does not occur in the neighbourhood of serpentine.

Sweden is still much poorer than the high lands of Norway. Save some spots of fossiliferous transition rock, and the more recent formations in Skonen, granite, or rather, according to G. Rose's description, gneiss, is almost the only formation which occurs. Wherever, in this rock, there appear veins of a coarse granular granite with oligoklase,* we find orthite, gadolinite, and yttro-tantalite: indeed, these, latter minerals are more universally spread than is generally believed.

* A species of felspar in which the cleavage is very imperfect.

On the Erratic Phenomena.

As to phenomena arising from the *erratic* system, it may be said, that these in Scandinavia are limited to striæ, produced by friction and (riesentöpfe) giant-pots. The erratic blocks are of less importance. By this, however, I do not mean to say, that one may not be as much in error in explaining this phenomenon as in others. I have seen polished and striated rocks on the sea-shore, so that the line of striation now passes under the level of the sea,—a proof that the tides are by no means inimical to the phenomena; but whether they may, therefore, be considered as causes of it, is by no means decided by this circumstance, for striated rocks are also found at a great distance from the ocean. In Tellemarken, striated or grooved lines, produced by friction, are to be seen 2000 feet above the level of the sea; on Gousta-Fjeld, they are observed even at 4000 feet. But the sea has certainly never reached so great a height in modern times. The rocks with the firmly-adhering barnacles (*Balanus*), near Christiania, which furnish the most striking proof of their having been once covered by the sea, lie only 400 feet above its level; and a little above this elevation, all traces of a marine diluvium seem to disappear. Though the fact is also established, that the level of the sea in Norway formerly stood higher, still that fact has no bearing on the striated character of the rocks in the high lands, which, doubtless, may be explained in the same way as the similar phenomenon in Switzerland. The matter stands otherwise in Sweden. The whole of this country lies very low, and the characteristic Scheren on the west coast extend with the same character, as naked and destitute of all vegetation, as they stand out in the midst of the sea, many miles distant in the interior of West Gothland, so that one is often inclined to believe, that the action of the waves of the Cattegat and Skagerrak upon these rocks was only a matter of yesterday. The same is the case on the shores of the Gulf of Bothnia. The time may easily be calculated, when the hills of Stockholm were hidden under the water, and the rocks are rising out of the sea, as it were before our eyes; but they issue forth rounded and striated from Neptune's workshop. The traveller in the south of Sweden has no need of compass, for every exposed rock shews him, by the direction of the striæ, the direction from north to south. In the same direction run those boulder-dikes, which characterise this phenomenon of Sweden.

There is no Asar in Norway, at least not in the middle and northern divisions. I do not know whether any occur on the south coast of Christiansandstift, but I would be inclined to doubt it. In Sweden, however, they often extend continuously over many miles, and their direction may be found in every travelling map; for, by reason of their great regularity, the highways in Småland and Södermanland are carried along these causeways. In the neighbourhood of Stockholm, of which Nor-Malm lies partly upon an Asar, I had occasion to examine one newly cut into. I then saw that it consists of nothing else than rounded boulder-stones, amongst which a certain stratification could not be mistaken. Nothing in it reminds one of moraines. As regards the striated character of the rocks, neither in this respect did they appear to me quite analogous to our Swiss phenomenon: the rocks are more rounded, and frequently deep furrows of a foot in breadth are washed out in them. Those very smooth mirror-like surfaces, such as the "shelle platte" in Handeckfalle, do not occur in Sweden. On the contrary, we frequently meet with the riesentöpfe or giant's pots, which do allow us to infer these have been produced by the washing of water.

Thus, if we are referred for the explanation to currents of water which moved sand and larger stones along the bottom, then the view of Mr Sefstrom, that this current was produced by the rising of the land, appears not quite evident; for this rising up of the coast from the sea appears far too gradual to allow even a small stone being moved from its place. We must have recourse to the theory of sudden and frequently interrupted risings; and this is a new hypothesis, in support of which there is no proof. Mr Professor Forchhammer sees in the phenomenon the effect of aqueous currents, such as still occur in all seas; and this mode of explanation strikes me as much more probable: it possesses the advantage of requiring no new hypothesis, since it explains every thing by existing facts and actions still going on. An accurate study of the phenomenon, and the collection of many individual facts, will assist in throwing a clear light on this subject. In Copenhagen there is preserved a large plate of limestone from Zealand, on which we distinctly perceive three different directions in the striated character, corresponding to the changes in the direction of the current of the sea, which have taken place in consequence of the gradual rising of the land. By the Sefstromean theory, which ascribes the phenomenon entirely to a sudden passing cause, a similar change in the direction of the striæ is left unexplained; for when the land suddenly rose up, and the water ran off, the latter would do so by the shortest way; and to this one direction only of the striæ corresponds. But the Forchhammercan current in the bottom of the sea must always vary its direction according to the configuration of the solid land, which would be changed by suddenly rising up: thus it is not surprising to observe more than one direction of the striæ on the same spot. This specimen in Copenhagen is therefore of great importance for the examination of the theories of the northern phenomenon, and certainly possesses attractions for us also, in enabling us to compare with it the similar phenomenon of our own country. I have obtained a cast of it in plaster of Paris, which Professor Forchhammer has already had the kindness to forward to me here.

My specimens, which partly I sent here from Norway, and partly brought with me, have all reached this in safety, and are already arranged and numbered. They are all, of course, intended for our museum. What I obtained by barter consists simply of a small, but very pretty and exactly determined, specimen of fossiliferous transition rocks from the island of Gothland, and from West Gothland: this I got from Professor Loven in Stockholm, to whom I have promised Swiss fossils in return; also specimens of fossils in Danish chalk, got from Professor Forchhammer in exchange for Swiss chalk fossils. In regard to simple minerals, I have been less fortunate. We cannot purchase any; for in the whole of Scandinavia there is not a single dealer in minerals, and even in Christiania and Stockholm people must procure the specimens of their own country from foreign dealers. I have received very complete specimens of the rare minerals of Sweden in a present from Captain Svanenberg and Axel Erdmann. All these, as I have already said, I have here in Berlin.—(*Mettheilungen der Natuforschenden Gesillschaft zu Bern. N.* 57 *and* 58, *January* 1846.)

On the Use of the Marine Hydrometer. By GEORGE BUCHANAN, Civil Engineer, F.R.S.E., President of the Royal Scottish Society of Arts. Communicated by the Royal Scottish Society of Arts.*

This is an instrument which I have found extremely useful in inquiries connected with the prevalence of sea or river water in different estuaries, with the view of determining the limits of these waters in respect of the sea. This forms not only a curious subject of investigation, but has become of great practical application in this country in connection with the interests of the salmon-fisheries. These we know in rivers are restricted in the modes of fishing, while in the sea they may be carried on freely by any means of catching, such as stake-nets or other fixed machinery. After the introduction of this modern improvement in the fishing, the great question arose, how to determine the limit between the river and the sea, and by it to fix the point where the restrictions were to be taken off, and the free use of fixed machinery was to begin. On this question much diversity of opinion has prevailed ; and among other tests was that of the prevalence of fresh or salt water.

Having been engaged in various inquiries of this nature, I found that for every purpose it was sufficient to test the qualities of the waters by their specific gravities, this being always an exact measure of the prevalence of sea or of fresh water in any mixture.

The specific gravities were accordingly measured by weighing each specimen in the usual way in a fine balance. But this method being tedious, and nearly inapplicable where a

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* Read before the Royal Scottish Society of Arts, January 24, 1848.

great number of specimens were to be tried on the spot, and during the progress of the surveys, it occurred to me, that something on the principle of the hydrometer might be introduced, which would facilitate the business ; and this is one of the instruments which I found to answer. It consists merely of a common spirit hydrometer-bulb, made so long as just to sink under the bulb in sea-water, and adapted with a very thin scale, so as to give greater sensibility, and measure the different shades of saltness with accuracy. Considerable difficulty was found in adapting this scale, as it must not only be thin, but light, otherwise it tends to overbalance the whole instrument. A thin slip of whalebone or ivory answers sufficiently well. A stem of glass would be desirable, but it is too slender, and liable to be broken. Here is an instrument entirely of brass, like the brewers' hydrometer, and will answer very well ; and I have no doubt, that in the hands of instrument-makers, a more finished and correct instrument could be constructed for general use ; and it would be curious to have experiments with such an instrument in different seas.

The general specific gravity of sea-water along the shores on the east coast of Scotland, I have found rarely to exceed 1026. Fresh water being 1000. The use of the instrument was shewn in different waters, and a very small impregnation of salt was visible in fresh water by the rising of the stem. A specimen from Granton Pier at low water was found 1024, shewing an impregnation of one part of fresh in 13 of salt, and at high water, it was exactly the same, and also the same at the top and bottom ; but this is seldom the case at the mouths of rivers and estuaries, the fresh water being found generally floating on the surface, particularly in rivers such as the North Esk in Forfarshire, which, making a rapid and sudden descent into the sea without an intervening estuary of any extent, no time is allowed for the mixture of the waters. I have frequently found the waters there perfectly fresh on the surface, and in the water at 4 or 5 feet deep, the hydrometer mounted nearly to the top of the scale, shewing the entire prevalence of the sea-water at that depth. After their descent into the open sea, the fresh waters float about on the surface for a long time, and are driven in different directions by the prevailing winds. At Queensferry, a specimen from the surface was shewn and tried, and found 1023, shewing 1 part of fresh in nearly 9 of salt, and at 14 fathoms down, it was 1023½, or 1 part fresh in 10½ salt. At Alloa, again, where the waters at low water are nearly quite fresh, yet at high water a specimen was shewn, which was found 1010½ at the surface, and at the bottom 1013, shewing a mixture of 10 parts of fresh in 16 salt, in the one case, and exactly half-and-half in the other.

In the Northern and Arctic Seas, it has been found by Dr Marcet, and Mr Scoresby, and Dr Fyfe, 1026·7, and nearly the same at all depths. Under the equator 1028. In the Mediterranean 1028·82, shewing that this sea is considerably salter than that of the oceans which surround the globe. But the saltest, at least the heaviest of all the waters on the earth is the Dead Sea, which is impregnated not only with salt, but also with sulphurous and bituminous ingredients. The specific gravity, from a specimen brought over many years ago by Mr Gordon of Clunie, was found to be 1211, shewing an impregnation eight times greater than sea-water.*

On the Normal presence of different Metals in the Human Blood.

M. E. Millon has addressed to the Academy of Sciences, a Memoir *on the Normal Presence of many Metals in the Human Blood, and an Analysis of the fixed Salts contained in that Liquid.*

Upon receiving the blood on issuing from a vein in about three times its volume of water, and introducing it after this dilution into a jar of gaseous (chlore) chlorine, it is seen to coagulate, become of a brown colour, and soon after forms a grey amorphous mass, in which the organisation of the sanguineous globules has entirely disappeared. By placing the whole in a fine cloth and squeezing it, a liquid flows out

* See Jameson's Philosophical Journal, vol. ii., 1820.

which runs rapidly through the filter and remains limpid. If we examine this reaction more closely, we will find a peculiar separation of the elements of the blood. The organic substances are found almost wholly in the coagulated portion; all the saline principles, on the contrary, are collected in the liquid. This division is made so completely, that on washing the coagulum and then calcining it, it is destroyed, without leaving any residuum. On the other hand, the liquid, when evaporated to dryness and burned in a tube used for organic analysis, affords so little carbonic acid, that at most we may estimate the proportion of the organic matters of the blood which the chlorine does not coagulate, at one in a hundred. It is easy to convince ourselves that the coagulum furnished by the organic principles does not contain the fixed salts of the blood—does not condense them—and encloses a quantity only proportionate to the quantity of water which impregnates it; so that if we weigh the water in which we received the blood, and weigh it again after mixture with the blood, we may act upon a known weight of filtered liquid, as on a determined weight of blood. This liquid accommodates itself so well to all analytic researches, both as regards quality and quantity, that we can immediately discover the quantity of one or other of the fixed salts of the blood. This method is in fact an analysis of the fixed salts of the blood, by the humid method, and M. Millon thinks that it will apply advantageously to other tissues and other liquids employed for economical purposes.

This facility in insulating the saline part of the blood has led M. Millon to other results. He states that he has proved that the blood of man constantly contains silex, manganese, lead, and copper. The proportion of silex and of the metals is sufficient to prevent any particular modification being required in their analysis. After evaporating to dryness the liquid set free by the action of the chlorine, the residuum is calcined for a few instants in order to remove the small quantity of organic matter which the chlorine has not rendered insoluble. The insoluble part of the ashes is then treated as a mineral substance, in which we find silex, lead, copper, and manganese. M. Millon has in this way found, that in

100 parts of this insoluble residuum, left by the ashes of the blood,

The Silex varies from		1 to 3 in 100
The Lead	,,	1 to 5 ,,
The Copper	,,	0·5 to 2·5 ,,
The Manganese	,,	10 to 24 ,,

After the determination, in this way rendered so easy, M. Millon wished to examine whether the copper and the lead were disseminated throughout the whole mass of the blood, or whether, like the iron, they are assembled in the sanguineous globules. 1 killogramme of coagulated blood, carefully separated from the serum of numerous bleedings, yielded him $0^{gr.}083$ of lead and copper. 1 killogramme of serum separated from the preceding coagulum, gave him only $0^{gr.}003$ of these two metals ; and M. Millon thinks that these three milligrammes of lead and copper contained in the serum, ought to be ascribed to the sanguineous globules dissolved or suspended in the lymph.

Then, he states in conclusion, the copper and lead are not in a state of diffusion through the blood ; they are fixed with the iron in the globules, and everything leads us to believe that they share with it organization and life.*

On procuring Crystallisations in the Dry Way, as explained in a Memoir laid before the French Academy of Sciences, and reported on by MM. BEUDANT, BERTHIER, and DUFRENOY. By M. EBELMEN.

The modern theories of geology, says M. Beudant, one of the reporters, render it necessary to admit that a great part of mineral substances are formed by fusion at a temperature more or less elevated ; that is to say, that the rocks anciently named *primitive*, formations of which we are now acquainted with belonging to all ages, are the result, like all the matters also which they contain, of a crystallisation by fusion. The probability of this assertion has beensupported by experi-

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* From L'Institut, No. 732, January 1848, p. 10.

ments of very old date, in which, by the melting of different substances, crystalline products have been obtained composed of different ingredients promiscuously intermingled; it has been corroborated since by the examination of scoriæ, &c. of smelting-houses, in which crystalline matters have been found identical with some of the natural substances occurring in the above mentioned rocks. Finally, it has been confirmed by direct experiments, in which, by fusion, certain minerals have been formed at pleasure, and many analogous substances. However, certain problems remained to be solved, as, fortunately for our successors, will always continue to be the case. Here, for example, matters more or less analogous to the minerals formed in our smelting houses (*usines*), such as we have directly formed by uniting the composing ingredients in suitable proportions, have all hitherto been fusible substances; but it very often happens in nature that such matters are accompanied by others which resist the most violent fires of our furnaces, and frequently also the latter envelope the former; thus quartz, corundum, spinel, and cymophane, &c., all infusible substances, are found along with others which melt more or less readily. It thence follows that we can attain to no certainty as to the origin of these matters; and if, by analogy, we admit that they have likewise been produced by fusion, we must suppose temperatures which we cannot produce but by means of blowpipes of detonating gas, with which only trifling attempts at crystallisation can be attempted. Consequently nothing positive could be ascertained respecting these bodies.

These doubts appear to have occupied M. Ebelmen's mind, and led him to the idea, from which important consequences may be derived. He conceived that it was not merely the fusion of substances at a temperature more or less elevated that might determine the combination of different elements, and the crystallisation of composite forms, but that it must likewise frequently happen that there will be real solutions of these substances, even of such as are infusible, in certain substances in fusion, just as there is a solution of different salts in water or other liquids; and that, consequently, crystallisations ought to be formed either by the evaporation of this new kind of dissolvent, or by the simple cooling of the solution made at a high temperature. It is under the first of these two points of view that he has undertaken a series of experiments, the result of which he has laid before the Academy.

M. Ebelmen immediately thought of the known dissolvents of this kind, such as boracic acid, phosphoric acid, the alkaline borates and phosphates, which dissolve, as is known, a considerable number of oxides when they are in a state of fusion, and have the property besides of volatilising slowly at a high temperature, whence it might be supposed that the solution would leave the dissolved substances under crystalline forms. The experiment completely succeeded, although made in circumstances by no means favourable; for it was carried on in the porcelain ovens of the royal manufactory, where they reach the maximum temperature very slowly, and stop it almost suddenly; so that there are only five or six hours for the evaporation of the dissolvent, during which crystallisation took place. It followed from this that only very small crystals could be obtained, and that, in many cases, none could be obtained at all. It is likewise proper to add, that the experiment is quite novel; and we do not know, with respect to these dissolvents, the degree of solubility of the different substances.

In spite of these obstacles, M. Ebelmen has made a series of experiments, the results of which are of high interest. On the one hand, by dissolving alumina in borate of soda or in boracic acid in fusion, he has made this substance crystallise, and has obtained the mineral known by the name of *corundum*, with all its characters. It is true that the crystals obtained are small, but perfectly formed, and possess all the characters of infusibility, great hardness, lustre, crystallisation, optical properties, and properties of composition, that we discern in the identical natural substances.

Thus the general problem is solved—infusible substances present no greater difficulties than the others; and besides, we are certain that we can henceforth obtain the crystallisation of a substance in a much more perfect manner than in all the experiments hitherto made.

But M. Ebelmen has not limited himself to the crystallisation of infusible substances. The means he conceived having been completely successful, he applied them to a different class of considerations, namely, to remove any doubt that might remain as to the composition of certain minerals, and clearly to establish analogies which hitherto rested only on conjecture. His first experiments having confirmed the composition $Al^2 O^3$, $Mg O$ for spinel, he wished to ascertain if its presumed isomorphisms could be substituted for the magnesia, and those of alumina could be substituted for that substance. This the natural compositions would lead us, on theory, to suppose, but the fact had never been clearly demonstrated.

For the magnesia, therefore, he successively substituted lime, protoxide of manganese, protoxide of iron, and protoxide of cobalt, and he obtained, if not always bodies crystallised in distinct regular octohedrons, at least bodies presenting positive indications of this form—the hardness, and all other characters like those of other spinels. He mingled many of these composites together, and the results were the same as when employing the magnesia alone. With regard to the substitution of baryte in the same proportional relations, it has yielded rather vague indications of crystallisation, but evidently belonging to another system, and resembling the result which the author had previously obtained by employing glucine, which produced cymophane artificially, in all respects identical with the natural substance, the composition of which, previously considered very probable, was thus completely verified.

M. Ebelmen proceeded in the same manner by replacing the alumina by its presumed isomorphisms, namely, the oxide of chrome $Cr^2 O^3$, the peroxide of iron, &c., in the atomic proportions of spinel, sometimes preserving the magnesia as a base, at other times substituting other bodies for it. In all his experiments he obtained matters completely analogous to the aluminate of magnesia, and, among others, the chromate of iron, quite analogous to spinel, thus removing all doubts on what has been called chromated iron or siderochrome. He has likewise ascertained that mixtures of these bodies with the aluminates of the same formula may be obtained artificially, as likewise with the ferrate of iron $Fe^2 O^3$, Fe O in all proportions, precisely as they are found in nature, a circumstance which has long embarrassed those mineralogists who do not well understand the relation of physical and chemical characters.

Thus isomorphisms which, according to facts of another nature, have hitherto been only probable in regard to substances which we had not the means of causing to crystallise at pleasure, are now found completely established by M. Ebelmen's experiments.

The reporter states further: The leading idea which M. Ebelmen has conceived, appears to us a richer one than he has represented it to us—no doubt because he wished to speak only of what he had made the subject of experiment, which has already yielded results of considerable importance. In its most general form, the idea consists of this, that many bodies in fusion probably possess the property of acting as dissolvents on many others, fusible as well as infusible. It does not appear absolutely necessary that these bodies should be capable of being volatilised in order to obtain from them a crystallisation of the dissolved substances, for with water only we may obtain crystals in vessels hermetically sealed, and consequently without evaporation, by the mere difference of the temperature of saturation and crystallisation. Now, since we find infusible bodies, such as quartz, corundum, spinel, cymophane, &c., as well as fusible bodies such as garnet, emerald, &c., in felspathic substances, in the granular carbonate of lime, &c., may we not suppose that these matters, in a state of fusion, have been the dissolvents? May we not also suppose the same thing of many others? These are at least fine subjects for experiment, which it will be of advantage to try; for if we may suppose, in consequence of M. Ebelmen's experiments, that boracic acid may be the vehicle of some great crystallisation, by way of formation, in some localities where we at present see it disengaged in abundance, it must be confessed that this body, as well as its compounds, is too rare among the products that issue from the bosom of the earth to ascribe to it the enormous mass which would have been required for the purpose mentioned.

However this may be, Beudant says, in terminating his report, we see, by the short exposition which has been given, that M. Ebelmen's idea appears to be a very fruitful one; that it has been conceived in the sound spirit of natural philosophy; that it has already furnished the means of verifying doubtful compositions in a great number of minerals, as well as of making many substances which nature has not yet presented to us, and thus filling up important blanks in general classifications; finally, that it has yielded positive and fundamental facts for science.

Agreeably to the conclusions of the report, the Academy decides that M. Ebelmen's Memoir shall be inserted in the Memoires of the Savants etrangers.*

Zoological Researches. By Professor Agassiz.

M. Duvernoy communicated a letter from M. Agassiz, dated Boston, 30th September 1847, and addressed to M. Alex. De Humboldt.

The zoological part of this letter relates to the inferior marine animals, and more particularly the Actiniæ, Lucernariæ, and some points in the anatomy of the Asterias and Echini.

It likewise contains many theoretical developments of the bilateral, from which M. Agassiz thinks he has discovered and demonstrated in Echinodermes, and which he supposes he has detected in a new species of Actinia, which he dredged from a depth of 140 feet. This species, which he proposes to dedicate to Captain Davis, under whose guidance he made an exploratory voyage of a month's duration, along the shores of Nantucket, is remarkable for the size of its tentacula, which are few in number, and widely open at their extremity.

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* From L'Institut, No. 731, January 1848, pp. 1–2.

After having observed that the contracted mouth forms a straight line, and that the tentacula are placed five by five, so as to form a regular pentagon, one of which is always in the prolongation of this line, the author thence concludes, that *there can no longer be any doubt as to the bilaterality of this polypus.*

It is our belief, on the contrary, says M. Duvernoy, that this conclusion can be no longer hazarded; and we pass on to his observations on the development of the Actinia, which appear to us to be of unquestionable interest.

"It remains for us to study the mode of formation and the increase in number of the tentacula. The same Actinia which enabled me to observe the symmetry of structure, furnished me with the means of doing this. One day I saw it deposit a packet of eggs, which were soon developed, and gave birth to young, provided with ten tentacula only, and of a distinct pentagonal form, which extended to the margin of the interior disc by which they were attached. At this period, the organisation of these animals is very easily understood; the vertical plates which divide the general cavity of the body are ten in number, and the stomach is suspended above this cavity, into which it opens below by a large aperture. A young Actinia, at this stage, resembles an Alcyonium; only in place of eight vertical bands, there are here ten plates, which advance considerably from the interior of the cavity, and which correspond to the ten tentacula of the circumference, or rather which intercept them. These plates are muscular, and, along with the circular fibres of the surface, determine the very varied forms we observe among these animals. The ovaries and the testicles, which are suspended to these plates, are developed at a very early period. The new tentacula are simple prominences on the circumference, which are formed on the outside of the already existing tentacula and between them. The walls of the new tentacula are then prolonged vertically, by projecting into the interior, and giving birth to new plates. In my new Actinia, the tentacula themselves are plaited on the interior, as is the whole animal, and I can distinctly see the fibres, or rather the longitudinal muscular fascicles which make them project. The general cavity of the body is filled with water, which enters by the mouth and stomach, as well as by the numerous microscopic pores arranged in vertical series in the walls, and which issues by the tentacula and these same walls. The produce of digestion constantly mingles with this water; but as the mouth, stomach, and extremity of the tentacula can be closed at pleasure, the diluted nutritive fluid may circulate for a long time between the plates of the general cavity of the body and in the tentacular tubes, before spreading itself exteriorly, and becoming farther diluted by the introduction of new water. In these animals, then, the same walls serve to elaborate the food, to separate the nutritious fluid, and make it undergo the necessary modifications for the purposes it has to fulfil; functions which, in the higher animals, are devolved on the particular apparatus of circulation and respiration.

I forgot to mention, that, in the same deposit, this same individual produced living young, as far advanced as those from the eggs, many days after their exclusion, and the eggs at very different degrees of development; so that this Actinia (which I shall describe under the name of *Rhodactinia Davisii*) is at the same time oviparous and viviparous. Having seen many similar successive layings, and having observed this fact in two distinct species, I am inclined to believe that it is the ordinary mode of reproduction among the Actinias.

I shall not speak to you of the numerous genera of Tubularia, Sertularia, and Bryozoaria, which I have had occasion to examine; this would lead me into an infinity of details which are not yet sufficiently digested.

Discarding the sponges from the class of Polypi, as having nothing to do with the animal kingdom, and also the Bryozoaria, which are true Molluscs, both in regard to their organisation and mode of development, this class contains a very natural group of animals extremely like each other; for, although we separate them into two great divisions, the Hydroides and Actinoides, it is not difficult to demonstrate the most intimate analogy between these two types.

The Hydroides have a general cavity of the body, below the stomach, into which the latter opens, as in the Actinia. The walls of this cavity are provided with longitudinal and circular muscular fibres, and the ovaries, suspended below the tentacula, nevertheless open into this general cavity, still as in Actinia. The clusters of the ovaria are simply reversed. The stomach itself likewise projects between the tentacula; but it opens into the general cavity of the body, as in the Actinia. The tentacula alone are really different, being filled instead of tubular (which renders their motions much less active), and the base of the body is prolonged in a stalk fixed to the ground. The difference between the Alcyons and the Actinias almost completely disappears, in proportion as we learn to recognise the analogy of their parts. Examine the stomach and ovaries, and you have a true Actinia.

I shall confine myself to saying that I am fully of Mr Edward's opinion, who brings the Bryozoaria near the Molluscs. I shall even add, that I am able, in some measure, to demonstrate in detail the analogy of these animals with the Acephali, from the disposition of their respiratory and fæcal orifices, to the arrangement of the interior organs.

An insulated fact of great interest observed in a Lucernaria is, that this polypus has ocelli, eight in number, identical in their appearance with the eyes of the Echinodermes and Medusæ, and placed in the notches among the tentacular fasciculæ.

Topography of the Pennine Alps, and Primitive Site of the Principal Species of Rocks found in an erratic state in the Basin of the Rhone. By M. A. Guyot. Communicated by the Author.

M. Guyot finished his explanation of the results of a journey he made last summer into the most elevated and least known portion of the Pennine Alps, the principal object of which was to search for the primitive situations of the erratic blocks of the basin of the Rhone.

He first remarked that the portion of the Alps comprised between Mont Blanc and Mont Rosa, or rather between Col du St Bernard and that of the Simplon, constituted the most elevated, most continuous, and most gigantic masses of the Hautes Alps. Its enormous breadth of base, the mean elevation of its cols and ridges, the height and number of its pics and aiguilles, surpass any thing of the same kind to be found in the celebrated masses of the Bernese Oberland, the Orteler, Oetzthaler-Ferner, and of Mont Blanc itself.

The group of Mont Rosa in particular, composed of the three chains of Mont Rosa, the Saasgrat, and the Weisshorn, in the centre of which lies the valley of Zermatt, brings together in a limited space from twenty to thirty peaks, all of which measure from 12,000 to 14,000 feet high. The ridge itself of this part of the Alps presents only immense fields of snow whence numerous glaciers descend; it is with difficulty accessible, and the wild valleys that lead to it are so uninviting to the traveller, that these regions, although situate in the very centre of Europe, have hitherto remained almost unknown. The best maps of Switzerland which we possess, although corrected of late years in some particulars, still present us with a very rough, and often altogether inaccurate, representation of these regions.

After ascending the valley of Salvan, and again observing in this classical region the moutonnéed rocks, and furrowed and striated rocks, which indicate the passage of ancient glaciers, M. Guyot, ascending the Col de Balme, again collected the diverse varieties of granite which descend from the numerous aiguilles of Mont Blanc, by the glaciers of Tour, Argentière, and Des Bois.

The complete identity of these varieties with those that compose the majority of the blocks scattered on the sides of the Jura, fully convinced him of the truth of what he had formerly advanced, namely, that it is from the western declivity of the Mont Blanc chain that the greater part of the Jura blocks are derived, while the varieties less talcose, and with a more equal granular structure, come principally from the Val Ferret or eastern declivity. Repassing by the Val Orsine and Tête-Noire, he visited the sites of the famous pudding-stones, which are one of the characteristic rocks of the basin of the Rhone, and remarked, on the summit of the Col de la Forclaz, numerous blocks of protogine, which indicate the height to which the glacier of Trient formerly rose.

M. Guyot penetrated into the heart of the Pennine Alps by the valley de Bagnes. He describes the various basins, at different stages, of which the valley is composed, and the numerous glaciers which surmount the savage hollows of this district. He at last arrived at the Chalet de Champriond, at the foot of the great glacier of Chermontane. This glacier is only the lower part of a vast mer de glace which turns suddenly to the north-east, and ascends by a gentle, almost imperceptible, slope as far as the ridge of the chain; it is the mer de glace of the great Otemma, which derives its name from the western peak which commands it. This vast field of ice, feeding eight lateral glaciers which descend from the eastern chain which bounds it, and four tributary glaciers suspended on the flanks of the great Otemma, has a regular system of moraines on its surface, each of which can be easily followed to its origin. These moraines convey the rocks of each of the summits before him to the feet of the traveller. The mer de glace of Otemma extends along the northern declivity, where it connects itself, according to the report of the chamois-hunters, with the great glaciers which descend to the bottom of the northern valleys. A range of high peaks which belong to the northern aspect, and which commence at some distance from the ridge, separates it into two branches, one of which is said to join the great glacier of Arolla on the east side, and the other, more to the north, confounds itself with the masses of ice which descend the northern sides of Som de Gietroz, in order to form the mass of the great glacier of Lenaret, at the bottom of the valley of Hermence.

On the south side, almost in the same direction, a glacier resembling a snowy valley descends from the south to the north of the Col de Crestasetz, to mingle its ices with those of Chermontane. The glacier of the Col de Fenêtre, which is separated from the former by the imposing mass of Mont Gelé, is very nearly parallel, but more to the west. It affords an easy passage, although covered with ice, into Piedmont, by the deep valley of Ollomont and the lower part of Val-Pelline; while by the Col de Crestasetz, which M. Guyot crossed, we descend across the ruins of neighbouring mountains, without any trace of a path, a little more to the east, on the elevated chalets of the village of Bionnaz, in the middle of the Val-Pelline. After ascending this deep and savage valley as far as the last chalet, that of Prarayé, he explored the bottom of the valley, which is occupied by the great glacier of Lisette. This glacier turns suddenly to the north, traverses, among high summits, the ridge of the chain, and here confounds itself in the superior plateaux with the great glacier of Ferpècle.

Retracing his steps, M. Guyot traversed the ice-covered Col of Mont Collon, from the summit of which the plateaux of snow extend without interruption to the superior glacier of Ferpècle. Three hours of rapid descent on the glacier of Arolla brought him to its lower extremity. This glacier follows a sinuous line, and turns westward round the base of Mont Collon, here traverses a tributary of the great glacier of Otemma, and resumes its northern direction before arriving at the first chalets. M. Guyot remarks how defective and insufficient our best maps of these lofty summits are to form a guide to the traveller. The map of Osterwald alone, not yet published, but of which M. Guyot had obtained a proof, gives a less imperfect sketch of them.

Not far from the Col de Collon, but at some distance from the ridge of the chain, a small chain commences with the Dent des Bouquetins, which descends towards the north, and separates the bottom of the val d'Erin into two valleys. To the west is the valley of Arolla, with the glacier of the same name; to the east, the origin of the val d'Erin, with the double glacier of the Ferpecle and Mont Miné. After descending the first of these valleys, M. Guyot went up the second, as far as the superior plateau from which the great glacier Ferpecle descends in immense cascades. These plateaux form in this place vast fields of snow from 10,000 to

11,000 feet in height, extending among the high summits of the Dent Blanche on the north, the Dent d'Erin on the south, and a great number of peaks towards the west, which rise here and there from the bosom of the plateaux, along the ridge of the chain or the smaller northern chains. These plateaux terminate towards the east in an abrupt wall of almost vertical rocks, at the bottom of which lies the glacier of Zmutt, at a giddy depth. This ridge of rocks, which unites the mass of the Dent Blanche with the Dent d'Erin, presents, on the south side, a sort of depression or less precipitous declivity to the foot of Dent d'Erin, by which the ice descends to the deep valley of Zmutt; this is the Col d'Erin, and the origin of the glacier of Zmutt.

A little to the north of the col rises a rounded eminence, which Forbes erroneously describes under the name of Stockhorn, which is a summit situate more to the south, and a little more elevated still. M. Guyot ascended the first mentioned of these, and gave it the name of Tête Blanche d'Erin. From this central point, elevated 11,000 feet above the sea, a most admirable panorama is unfolded to the eye. On the east side, the view extends over the gigantic chains of Cervin, Mont Rosa, and Saasgrat; to the north and north-east, over those of Dent Blanche and Weisshorn; to the west, the prospect reaches beyond the vast plateaux of snow which lie at your feet, as far as Mont Collon, and Combin; so that, at a single glance, the eye takes in all this vast chain of the Pennine Alps.

It will be seen, from what has been said, that one of the characteristic features of this high chain are the extensive plateaux which crown the summit. The highest points rarely touch each other so as to form an uninterrupted series: here and there considerable gaps lie between the two declivities, and form those cols with insensible slopes, which, like the mer de glace of Otemma, rather resemble large valleys with a flat bottom than cols which traverse the ridge of one of the most elevated chains of the Alps. On the northern aspect, in particular, the northern links of the chain originate in the very bosom of the plateaux, and not from the summit itself, so that they seem to be without a point of attachment.

To these details, M. Guyot has added others respecting the bottom of the valleys of Torrent and Zinal, which, when united, form the deep valley of Anniviers. He points out many corrections to be made in the topography and nomenclature of the peaks of these regions, as given by Fröbel. He describes the appearance of the upper valley of Tourtemagne and the glaciers of Weisshorn, which occupy the bottom; then, passing the difficult and elevated Col of Joung, he ascends the valley of St Nicolas and Zermatt, again examining the glaciers and rocks, traverses that of Saas, where he determines the precise situation of the euphotides, and enters by the Monte Moro, in the Piedmontese valley of Macugnaga. From this point, traversing the Turlo, he successively went through all the southern valleys of Mont Rosa, which he examined particularly, with a view to the erratic formation, and the rocks which they furnish.

The valley of Aoste appeared to him of the highest interest in this point of view.

From the height of the Col de Joux or of Amaï, by which M. Guyot entered this large and beautiful valley, the eye takes in the greater part of its extent at a single glance. From this view, we may conceive beforehand the part that must have been performed during the period of extensive ice, by this vast reservoir, comprised between the massive heights of the Pennine Alps, the elevated and compound chain of the mountains of Cogne, having at its head the chain of Mont Blanc, by which the view is arrested in front, at the horizon. This presentiment is speedily confirmed. On descending the Col towards the baths of St Vincent, we already perceive considerable masses of erratic formation, blocks and pebbles of serpentine and chlorite, mingled with glacial mud. These masses, suspended on the torn and abrupt flanks of the mountain at more than 1500 feet above the valley, indicate the pressure, at another era, as well as the thickness of the ancient glaciers. Farther down, in the region of the vines, the blocks become more frequent and of larger size.

From St Vincent, as far as Ivrée, there is scarcely any rock among those bordering the road, and even to a considerable height, which is not moutonné, grooved or striated in the most characteristic manner. All the hills are cupola-shaped. A little below St Vincent, we already notice an insulated rock in the middle of the valley, which seems to issue from below the glacier. Further on, the heights which crown the old fort of Mont Jovet, the hill on which the impregnable fort of Bard is situated, and all the neighbouring rocks, are likewise moutonnés, and furrowed in the most admirable manner. At the opening of the valley, in the neighbourhood of Ivrée, all the hills, comprising the diorite around that town, exhibit these characters in the highest degree. It may be said, that wherever the rock is exposed, it shews the corroding marks of the erratic agent. Nowhere are they so marked as at the narrow parts of the valley, especially below St Vincent, at Mont Jovet, and Fort de Bard; and we may observe here, as elsewhere in the same circumstances, the tendency of the furrows to ascend in a direction contrary to the slope of the valley.

Beyond Ivrée, the erratic phenomena present themselves in a form as grand as it is novel. To the east of this town, the horizon is bounded by a large, steep hill, composed entirely of pebbles, mud, and erratic blocks. This is the hill of Serra, which rises from the side of Mont St André to two-thirds of its height, and descends in an inclined and regular line towards the plain, turning its abrupt face to the west. This is a true moraine, analogous to the great erratic bar which extends from the rocks of Memise to Thonon, on the left bank of the lake of Geneva, but even more strongly characterised. M. Studer has already pointed it out as such to the attention of geologists. Towards the south, in the axis of the opening of the valley, on the road from Ivrée to Chivasso, we meet with many masses of erratic debris in the form of arched bands, the true terminal moraines of the great glacier of Aoste. The first appears at Strambino, the second at Candia, the third at Calusso; beyond the latter village, the levelled plain and ancient diluvium of Lombardy commence. In this place, as in Brianza, at the mouth of the Lake of Como, and on the banks of Lake Maggiore and Lake

Orta, we distinctly distinguish the character and superposition of the two formations.

These facts, in themselves so significant, are not the only ones of this nature observed in this valley. M. the Canon Carrel has proved the existence, on a large scale, of all the same phenomena in the neighbourhood of the city of Aoste. Many years previously, M. Guyot had pointed out very beautiful polished rocks at the foot of Mont Blanc, above Courmayeur, where they were likewise seen by MM. Agassiz and Forbes. This assemblage of facts authorises us, in M. Guyot's opinion, to consider the valley of Aoste, viewed in relation to the development of the erratic phenomena, as analogous to the valley of the Rhone. It is, in regard to the southern declivity of the Pennine chain, and the Italian side of Mont Blanc, what the Valais is to the northern declivity of these two chains; it is even superior to the latter in the number and evidence of polished and moutonnéed rocks, and, in this respect, it does not yield even to the classical valley of the Aar.

As to the essential object M. Guyot had in view in this exploratory journey, namely, to determine the precise site of the species of rocks of the erratic basin of the Rhone, the origin of which was not sufficiently clear, he has completely succeeded in attaining it.

He was particularly careful to obtain specimens *in situ* of the chloriteous gneiss and arkesine scattered in such great abundance in the plain. No one had previously done this. M. Guyot had only indicated the bottom of the valley of Bagnes and the valley of Viège, where these rocks had been observed in an erratic state by himself, and previously by MM. Studer and Forbes, as the extreme limits of their extension. He soon convinced himself that these rocks and their varieties, accompanied with diverse amphibolic rocks, constitute, in a great measure, the central mass and the highest summits of the Pennine chain. In the bottom of the valley of Bagnes, after passing the region of the chlorites, we immediately find the chloriteous gneiss and arkesine in great abundance on the glacier of Brena, at the western base of the Champriond, where these rocks, almost of themselves, form the fine, frontal moraines left by this glacier. The glacier of

Chermontane and the mer de glace of the great Otemma, scarcely exhibit anything else, in their numerous moraines, than very diversified varieties of these same rocks, generally of a dull colour, among which we can distinguish many rich in epidote. The mountain of the great Otemma itself is, in a great measure, formed of chloriteous gneiss. This rock loses more and more its slaty structure, as we advance to the top of the chain, and near that point it assumes the appearance of a granite, with large ill-defined crystals of felspar, and of a slight rose-colour.

The opposite chain, which comprehends the mass of the Trumma de Bouc, and which is prolonged by the Col de Crestasetz as far as Val-Pelline, is likewise composed of chloriteous gneiss, in which the proportion of the constituent parts is very variable, according to the localities. In the last mentioned valley, the rock seems to pass, by almost insensible transitions, into a true syenite. The chloriteous gneiss, but not the arkesine, is still frequently found in the Val-Pelline, or, on ascending the valley, we see it alternating with the syenites, and other rocks less distinctly characterised. Towards the bottom of this valley, as far as the glacier of Lisette, amphibolic rocks and talcose limestones or cipolins succeed, and present petrographic forms of the highest interest in ref erence tothetheory of metamorphism.

At the Col de Collon, and along the glacier of Arolla, the chloriteous gneiss and arkesines reappear, but under less normal forms. The proportion of the amphibolic rocks, syenites, and species which may be more directly connected with the green granite, greatly increase. It may even be said, that they are dominant as far as the tributary of the grand Otemma, which brings specimens whose forms approach more and more to the types of the two rocks in question.

But the true granitoidal arkesine and chloriteous gneiss with shining particles, such as they are usually found in the plain, reappear in the masses which surround the glacier of Ferpècle. The tributary glaciers which descend from the Dent Blanche in particular, carry along with them scarcely any other rocks than arkesines; and these are, in part, distinguishable from those of the Otemma and Chermontane, by more crystalline forms, and a general tint of deeper yellow. Mont Miné also yields chloriteous gneiss, but it is rather syenites and various rocks rich in amphibole, which predominate there.

More to the east, the arkesine and chloriteous gneiss disappear, and seem to be wanting in the chain of the Weisshorn. At least, M. Guyot scarcely met with any in the valleys of Anniviers and Tourtemagne, which descend from this great chain; and the numerous blocks of these two species which he noticed on the glacier of Zmutt, and on the heights which overlook its left bank, evidently come from the Dent Blanche.

We thus see that the chlorites, the chloriteous gneiss, and the arkesines, as well as the green granites, syenites, and other amphibolic rocks, belong to the most central, and most elevated part,—in a word, to the axis of this high chain of the Pennine Alps situate between the bottom of the val de Bagnes and the col d'Erin. It is in these almost inaccessible peaks, and in the bosom of the glaciers that descend from them, that we must seek for the rocks from which have been detached the erratic masses, at once the most numerous, most colossal, and most widely distributed on the surface of the basin of the Rhine. How surprising that their primitive site should have remained so long unknown!

The group of erratic species to which M. Guyot, with a just title, has given the name of Pennine rocks, likewise belongs to this elevated chain. These rocks have issued from it by two principal channels only, the valley of Erin and that of Bagnes. The valley of Viège furnishes only a small number of them, for this may be considered an accidental outlet for these rocks, while it is the principal, indeed the only canal, by which the rocks of Mont Rosa have been brought down to the valley of the Rhone.

The group of the Mont Rosa rocks contains species only whose place of origin was previously in some degree determined. The principal site of the serpentines is the region lying between the great Cervin and the Lyskamm. The chain of the Riffel, likewise composed of serpentines and which is prolonged eastward into the Saasgrat, may be regarded as depending on this part of the central ridge. The glacier of Schwarzwald, at the foot of Monte Moro, near lake Matmark, brings numerous blocks of serpentine from the bottom of the upper valley of Saas, among which two enormous masses are observed, left, a few years ago, on the border of the path by the glacier, the most considerable of which is looked upon as the largest erratic block known. Some other sites, further down near Vièges, are of less importance.

With regard to the euphotides, M. Guyot adds to what he had formerly stated regarding their original site, that he is convinced their point of departure is the rocks which overlook the upper part of the glacier of Alalein, particularly on the left side and a little below the highest summits. The eclogites, not so strictly localised, pass along the western declivity, and descend by the moraines of the glacier of Finelen, in which M. Guyot collected many varieties.

The greater part of the serpentine debris has therefore descended by the valley of St Nicolas, a small quantity only by that of Saas. The reverse of this holds true with the eclogites. The euphotides come exclusively from the valley of Saas.

M. Guyot terminates his communication by a few petrographic considerations on the two groups of the Pennine rocks and the rocks of Mont Rosa. A frequent comparison of the various species and their numerous varieties, as well as an inspection of their respective sites, leads him to think that their association into two distinct groups, is not only a geographical fact, as the names he has given to each of them would induce us to believe, but that it is justified also by their nature. He is induced to believe that these groups really form two metamorphic series, and he mentions that he has numerous specimens in his collection, which shew the almost insensible transition of the species of each of these two groups into one another. He likewise exhibits many specimens obtained *in situ*, of each of these species, represented by their most widely diffused types, and compared with specimens collected in an erratic state in the different parts of the basin of the Rhone, whose complete identity with the first is obvious to the least experienced eye.

On Shooting Stars. By Sir J. W. Lubbock, Bart.

As the phenomena of shooting stars (*stella cadens*) are interesting, from their connection with the structure of our planetary system, we have much pleasure in communicating the following observations on these remarkable bodies, from the last Number of the Philosophical Magazine, by Sir J. W. Lubbock, Bart. I wish, says Sir J. W. Lubbock to the conductor of the Philosophical Magazine, to correct an oversight in page 85 of the last Number of the Philosophical Magazine, where it is implied that the same *shooting star* may be observed to disappear at different instants of time by different observers. It is obvious that if the moving body cease to shine, by reason of its entering the shadow of the earth, this event is entirely irrespective of the position of the observer; and, therefore, if it should be observed by more than one person, such observations will furnish the parallax, and may determine whether this mode of accounting for the disappearance of the star is correct or not. If it has been attempted to determine the differences of terrestrial longitude by such observations, probably the materials exist somewhere by which the accuracy of the hypothesis can at once be tested. It may possibly however, be again observed on the same night, either by the same or different observers, after an entire revolution.

It has been the subject of speculation, whether such bodies owe their origin to violent action at the moon's surface. But observers are, I believe, agreed that the surface of the moon offers no evidence of great agitation. The indentations of the surface remain unchanged, and no phenomena have, I believe, been seen which indicate the existence of volcanoes, which might discharge small bodies with great force, and thus give rise to the satellites of the earth.

The case is widely different as regards the sun. Changes of enormous magnitude are continually witnessed on its surface, which indicate the action of forces agitating the mass probably in a state of fluidity. Recently I have observed spots which were even visible to the naked eye, and of which, on the following and succeeding days, not a trace could be found by a good telescope.

If a body were thrown up from the sun's surface, it must, omitting all consideration of the planets, describe an ellipse having the centre of the sun in one of the foci; and, thus, however great the force by which the body may be supposed to have been discharged, it must return to the sun, and impinging upon it, would not perform even one entire revolution. If, however, we consider the action of the other planets, and especially of Jupiter, it seems by no means impossible that in returning, a body so discharged might clear the sun, and perform many complete revolutions round the primary, that is, might become a comet (*or shooting star.*) It would be interesting to ascertain how much the perihelion distance of such a body might be lengthened under given circumstances of the action of Jupiter ; or whether, under any hypothesis of the configuration of the planets, the perihelion distance of any known comet could be brought under ·004647. Le Verrier suggests, that some of the comets may have become fixed to our system, and retained by the action of Jupiter; and that in consequence of the same action, they may again wander in space, and cease to belong to this system.* But may not such bodies owe their origin to the same forces of which the existence is indubitable, which operate on the surface at any rate of the sun's mass ? And if so, it is by no means impossible, that, by calculating the perturbations of some comet for the past, especially one whose perihelion distance is small, it may be traced back to its origin, and the very year ascertained when it left the solar mass.

The phenomena of *shooting stars* may possibly throw light upon the question of the extent to which an atmosphere extends, capable of affording any sensible resistance to the motion of such bodies, and may thus afford an interesting illustration of the connexion which exists between different branches of physical science. In my treatise on the Heat of Vapours, p. 43, I have given a table, shewing, upon the hypothesis I there adopted, the density and temperature for a given height above the earth's surface. According to that hypothesis, at a height of 15 miles the temperature is 240°·6 F., below zero the density is 03573, and the atmosphere ceases altogether at a height of 22·35 miles. In the *Comptes Rendus des Séances de l'Academie des Sciences*, tom. viii. p. 95, M. Biot has verified a calculation of Lambert, who found from the phenomena of twilight, the altitude of the atmosphere to be about 18 miles. The constitution of the higher regions of the atmosphere, according to the hypothesis adopted by Ivory is very different, and extends to a much greater height. See p. 3, of the Supplement to my Treatise on the Heat of Vapours, where I have given a table, shewing the construction of the atmosphere according to Ivory. Such a table for the constitution due to Laplace's hypothesis is still wanted.—(*The Philosophical Magazine, Third Series*, vol. xxxii. p. 170, March 1848.)

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* "Dans un certain nombre de siècles toutefois, elle atteindra de nouveau l'orbite de Jupiter, dans une direction opposée à celle par laquelle elle a par arriver dans le systéme planétaire; et son cours sera certainement encore fois altéré-Peut-etre même Jupiter la rendra-t-il aux espaces aux quels il l'avait dérobée."—Le Verrier, *Comptes Rendus*, Dec. 20, 1847, p. 925.

Further Progress of Mr Jameson's great Tea-Planting Operations in India, under the Patronage and Direction of the Honourable The East India Company.

We mentioned some short time ago, on the authority of the *Star*, that Government had sanctioned an outlay of one hundred thousand rupees for the carrying on the tea-plantation experiments on a most extensive scale, under the superintendence of Mr Jameson. We also intimated before, that this officer had been deputed to examine the hill-country west of the Jumna, as to its capabilities for tea-planting. We have now the pleasure to announce that the grant is to extend over a series of years at the rate of one lakh (£12,000) per annum; and that Mr Jameson has been for upwards of a month engaged in the delightful occupation of selecting sites for tea plantations. He has already given it as his opinion that Annandale and Kotghur, in the Simla jurisdiction, are suited to the object in view, and crossing the Sutlej at Kotghur, he has proceeded as far as Kangra *via* Kooloo and Mundee. A friend, who has had opportunities of hearing Mr Jameson's account, says he was highly gratified to see the change that is coming over the former country. "Villages are now being built everywhere on the old sites of those that were burnt and destroyed by the Sikhs." At Gumpta is the descent into the Beeas valley, which is a magnificent plain, well irrigated, but only half cultivated, owing to the thinness of the population. After the Beeas valley there is a series of valleys on to Noorpoor, viz. the Paklun, Kangra, Rilloo, &c., varying in height from 3000 to 4500 feet, and separated from each other by small ranges of hills running N. and S. To the north these valleys are bounded by a high range, now, according to a correspondent at Kangra, more than half covered with snow, and to the south by a lower range. They vary in breadth from three to four miles, and are about eighty miles in length; the general dip of the country is to the south; and from the northern boundary a number of streams take their rise, irrigating the valleys in a most efficient manner. The revenue derived from these valleys is at present about two lakhs (£25,000) of rupees. We hear that all of them are admirably adapted for tea; and as soon as the plant is brought generally under cultivation, as must be the case, we doubt not the revenue will be increased cent. per cent., if not considerably more. In the Beeas, Paklun, Kangra, and Rilloo valleys, there is, we are assured, nearly as much land adapted for tea cultivation as would, if thus used, supply the whole European market. The principal products now cultivated are rice, wheat, and sugar; the latter is described as wretchedly poor, being very small, and containing but little saccharine matter. We are told that much as has been written and said of the Dhera Dhoon and its capabilities, it falls far short of the Kangra and Rilloo valleys. "They are undoubtedly," says a correspondent who has opportunities of examining them, "the Eden of our hill territories. In the Dhoon water is, in many places, scanty; here there is much more than is required. Here and there you meet large streams containing a body of water superior in quantity to that supplying the Dhoon canals, yet considered of so small importance as to be nameless. In every direction the valleys are intersected by kucha canals." We learn, therefore, with much satisfaction, that many sites for tea plantations have already been selected in these valleys, one in Paklun, now a waste, some 4 miles by 3. In the Kangra valley, the largest site as yet chosen is a waste plain, upwards of a mile long, near Dhurmsala. It is clear, that in a very few years, these valleys must become important on account of their tea cultivation, as our friend says that the smaller sites selected by Mr Jameson are too numerous to mention. At present, tea is imported from Yarkund, in Noorpoor, packed in bulk (as our local readers may ascertain by inspection of the tea-blocks to be sold on the 27th at the Begum's house, on account of Government, and from thence to the Punjab). It is much valued by the natives, and the finer sorts are sold as high as six rupees, a proof that the use of tea would become much more general, in that as in other quarters, provided it was sold at a lower and reasonable rate. In order to insure the success of the experiments now about to be carried out, on the liberal scale already mentioned, we have been told that His Excellency the British Plenipotentiary at Hong Kong, Sir John Davis, has been requested to send two additional sets of Chinese tea manufacturers, also seeds from all the most celebrated districts in China. The latter, on arrival at Calcutta, are to be sent up letter dak, so that a considerable proportion, if not all, stand the chance of arriving in a vegetating condition. We were informed a short time ago, that the manufactory of tea had commenced in the Dhoon, but now learn that the information was premature; none was prepared there last season; but the requisite buildings being now ready, it is hoped the manufacture will commence next year (in April). It is intended, as soon as the new "manipulators" arrive from China, to send one set to Kangra, which must ultimately become the most important tea district, and to keep the other in the Dhoon. As soon as the Kutturputtur canal, to which Lieutenant Hutchison has been lately appointed, is cut, the superintendent of the tea-grounds has been authorised to establish a large plantation there. After he has selected the land best adapted for his purpose, *the remainder is to be sold to the highest bidder.* The Dherah Dhoon certainly possesses one advantage over the hill-country beyond the Sutlej, and that consists in the facility of transit presented by the Jumna and Ganges. At Kangra, the distance from the plains is four marches; but these once got over, the Sutlej and Indus will afford an excellent outlet to Bombay. The arrangements now in progress will, in a few years, put the government in possession of vast tea-forests from the banks of the Kalee to Noorpore, and those who formerly considered the idea of supplying the home market with tea from India as a mere chimera, must ere long be convinced that the thing *is* to be done. The quantity of seeds produced in Gurwal and Kumaon this season, exceeded *one hundred* maunds; besides which, the tea-plant is easily reared from cuttings and layers. The superintendent, to whom these extensive arrangements have been entrusted, has been vested with unlimited power as to the situation of sites, the appointment of cultivators, &c., and the various officers, in whose districts he is now engaged, have afforded him every assistance, as but one opinion prevails amongst them regarding "rapid extension."—*Delhi Gazette, December* 15, 1847.

A Discourse on Draining and Irrigation, delivered before the General Agricultural Society of Barbadoes, at its Fourth Half-yearly Meeting, on the 22*d of December* 1847. By JOHN DAVY, M.D., F.R.S., Inspector-General of Army Hospitals, Honorary Member of the Society. Communicated by the Author.

GENTLEMEN,—On this occasion I propose to bring under your notice, the important and nearly allied subjects of DRAINING and IRRIGATION; important, as conducive greatly to fertility; and nearly allied, the mean element in both being water, without which, soils of the very best quality you know are barren.

Limited as we are for time, were there not other reasons for it, I must, in this short Discourse, which I have now the honour of addressing to you, restrict myself in a great measure to principles,—and avoid the details of the operations, whether of Draining or Irrigation. Should I be so fortunate as to enunciate clearly the former, and to convince any individual present, doubtful of the efficacy of these processes, that draining, or thorough-drained land is essential to Agriculture,—if it be the intent, as it should be the interest of the Agriculturist, to conduct it in the most improved manner; and that Irrigation, wherever practical, most amply repays by imparting a wonderfully increased fertility;—should I be able to accomplish thus much, I shall not regret passing over the minutiæ of details—which are best studied and learnt in systematic works on the subject, that is, if practical means of instruction are not available, which are the best of all.

The kind of draining to which I have to call your attention, is not the common surface-draining, but the new and far more advantageous method of deep and thorough-draining, a method by which the excess of rain is conveyed from the surface of the land into its substance, and even to the subsoil and beneath it; to be retained in moderate quantity favourable to tillage,—favourable to vegetation,—favourable to the disintegration and decomposition of the coarse parts of the soil, and of the subsoil, and consequently to the improvement of the quality of the soil, and to the formation of new soil fit for tillage.

These effects, so admirable, can only be elucidated and brought clearly to the understanding, by considering the principles of the operation; or in other words, the qualities of the different substances concerned, as of the soil and subsoil, and their elements, in conjunction with rain and atmospheric air, and their agencies.

A soil fit for cultivation is never formed of any single earth—it is more or less compounded, and the greater in degree, generally, the better is its quality. In all good soils there is a certain proportion of clay, and commonly of sand, either silicious or calcareous, or a mixture of the two. What is designated clay, always consists of many ingredients,—of which alumine and silica are the principal. In three specimens from fertile soils in Flanders, carefully analysed, besides alumine and silica, there were found present eighteen other substances,—the most important of which were lime and magnesia, the alkalies—including ammonia, certain acids—as the phosphoric, sulphuric, and carbonic, and two or three kinds of vegetable matter.

The peculiar quality of clay is, that it is retentive of moisture, and of the most complete clay in its condensed state, using the term in contradistinction to a loose state,—that it is an obstruction to flowing water—a property of vast importance in the economy of nature,—without which, the earth would be, in great measure destitute of springs,—the ground arid and unfit for vegetation, giving rise to a universal desert-waste. This peculiar property is mainly dependent on one earth, viz., alumine; and on the circumstance that when separated in consequence of the decomposition of the mineral compounds in which it exists, it is, as when obtained by precipitation, by the addition of an alkali to a salt of alumine in solution, in a state of extraordinarily minute division, with the power of adhesion particle to particle, and of becoming plastic from compression; a power this, of the first importance in the economy of soils, without which, it is obvious the surface of the Earth would be in the state of a moveable, drifting sand, such as we find where the binding element of clay is deficient, as in the instance of the most remarkable deserts. Of this state of minute division, you may satisfy yourself most easily by a simple experiment—the precipitating of alumine from a solution of alum by ammonia, and examining it under the Microscope. So minute are the particles of the precipitate, that even when using one of the highest powers of a good instrument, a glass, for instance, with a focal distance of one eighth of an inch, they are hardly distinguishable—indeed, I may say, they are not distinguishable individually,—only when connected one with another. This state of minute division of the detached alumine is connected with, and may be dependent on another property of this earth, its perfect insolubility in water, and in water impregnated with carbonic acid, and owing to this insolubility, its inaptitude, when so detached, to form crystals.

To appreciate these peculiarities of alumine, let us consider for a moment the qualities of the other earths, which are the other chief ingredients of soils, viz., silica, lime, and magnesia.

Silica occurs in soils chiefly in the form of quartzose sand, derived from the disintegration of certain compound crystalline rocks, especially granite, of which rock it is an ingredient. It also occurs in smaller proportion, in a very finely-divided state, when derived, it may be inferred, like alumine, from the decomposition of certain minerals containing it, such as felspar. In this state it is soluble either by means of carbonated alkali, or carbonic acid alone, as I believe, or water alone, according to a distinguished Swedish chemist. Owing to this quality it is capable of entering into the composition of vegetable textures. When deposited from its solution, it is not in the manner of alumine, but either in minute adhering crystals, or uncrystallized in the form of a compact hard stony crust.

Lime exists in the soil most generally in the state of carbonate of lime; even if introduced in the caustic state, owing to its strong affinity for carbonic acid, it rapidly absorbs this gas from the atmosphere. The carbonate has a strong tendency to crystallize: it undergoes crystallization in the act of its formation, when the lime is absorbing carbonic acid. If you precipitate lime from a solution of one of its salts in water by an alkaline carbonate, the carbonate of lime thus obtained will be in minute crystalline grains,—minute, according to our ordinary ideas of bulk, but coarse indeed, if compared under the microscope with the precipitate of alumine. Nor has it the property of alumine, as you may satisfy yourselves by a very easy experiment, of retaining or preventing the flow of water.

Magnesia, like lime, having a considerable affinity for carbonic acid, commonly exists in the soil in the state of carbonate. But it has not the same disposition to crystallize, and in consequence, perhaps, its particles are finer; at least this may be inferred from the examination of the carbonate, artificially obtained by precipitation by a carbonated alkali, added to the solution of a magnesian salt. These, though finer than those of carbonate of lime procured in the same manner, are visible individually under the microscope; and are therefore very much larger than those of alumine. And tested by water, the carbonate of magnesia is found to retard, not entirely prevent, its flow and transmission.

The relative minuteness of the particles of these three earths is well shewn by the time required by each to subside after suspension in water by agitation. It will be found that the carbonate of lime will descend and find its place of rest rapidly; the carbonate of magnesia in slower time; and the alumine by far the slowest. And hence the wide diffusion of this last-mentioned earth—a happy circumstance in the economy of nature. Washed out of the naked disintegrating rocks by rain, with mineral particles of other kinds, not so minute, but hardly less diffusible, they are carried by rivers into seas, and by tides and currents transported even into the ocean; there they subside and form beds, destined, it may be, to become fertile soils on islands or even continents, should the rocky foundations on which they rest be elevated into the atmosphere, as this island has been, and so many others—covered with beds of clay and soil, which we are sure from their nature are of distant origin.

Another peculiarity of alumine requires notice, in connection with thorough-draining, to wit, its power of contracting in drying. No earth absorbs so much water,—whether chemically or hygroscopically,* no one retains it so powerfully, or contracts so much in losing it. There are before you precipitates, dried, of alumine, of carbonate of lime, and of carbonate of magnesia. How great is the difference in their appearance! that of the alumine is fissured in every direction; that of the carbonate of magnesia exhibts only a very few fissures; whilst the carbonate of lime has a smooth unbroken surface, indicating no contraction.

The two peculiar properties of alumine adverted to, and which are also properties of clays, chiefly depending on the presence of alumine, viz., being impermeable to water when expanded by it,—that is, when containing a certain quantity without a free outlet, such as a drain affords; and being liable to contract, and become fissured and so permeable, on losing water, such as is drawn off by a drain; these two properties may be considered fundamental ones in connexion with thorough-draining,—the first giving rise to the necessity for the operation,—the second rendering it practicable. In the first instance, it must be supposed, or taken for granted, that the clay is not so compact or condensed by pressure as to allow no passage to water, even with a free outlet, which is a quality, as already remarked of the purest clays.

For this, the deep and thorough mode of draining, to be most efficient, should by followed by subsoil-ploughing, which breaks up the clay to a certain depth, and renders it more pervious to water and the access of air, without bringing any of the subsoil to the surface. The effect of subsoil-ploughing, it may be remarked, is well illustrated, by taking a piece of stiff clay and breaking it up, when it will be found to be readily permeable by water; and again, when the water has been drained from it, compressing it as a plastic mass, when it will recover more or less its impermeability, accord-

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* Wet alumine, from which water had ceased to drop, compared with wet carbonate of lime and fine silicious sand, from which water poured on them in a filter of bibulous paper, had also ceased to drop, lost, I find, in drying, 22 per cent. more water than the carbonate of lime, and 36 per cent. more than the silicious sand: thus, the alumine lost 60·8 per cent.; carbonate of lime 38·7; and the fine silicious sand 24·4 per cent.,—at a temperature of air of about 80° Fahr., and when there was a difference of about 10° between the moistened bulb and dry bulb thermometer. Farther, it may be mentioned, that the alumine kept over strong sulphuric acid, lost 10 per cent. more of water, whilst the carbonate of lime lost only four-tenths, and the sand only two per cent. The carbonate of lime and silicious sand kept over water, shewed no appreciable hygroscopic power; their weight was not sensibly increased; the alumine similarly placed, after having been similarly dried in the air, acquired water to the extent of 8·6 per cent. The avidity with which alumine sucks in water is remarkable; it is indicated by the loud crackling noise attending it. I would ask, may not some of the subterraneous sounds not unfrequent in certain clay districts, especially in climates subject to long droughts, followed by heavy rains, be owing to this cause?

ing to its quality,—that is, the proportion of finely-divided aluminous matter it contains, and the proportion of sand. As it appears that in some instances this process of subsoil-ploughing has been of little advantage, not repaying the cost, it may be prudent to try the effect of it on a small portion of the drained land, and to be guided by the result as to its extension,—for example, the quality and quantity of produce on the portion subsoiled, compared with the quality and quantity of the crop on an equal portion merely drained.

Allow me now to turn your attention to the atmospheric air, and to the rain-water, for the admission and penetrating of which into the soil, without stagnation of the latter, thorough-draining, as regards its function, may be considered in the first place as instituted.

Atmospheric air, we know, is composed of oxygen and azote and carbonic acid in almost constantly the same proportion, viz., 21 parts in volume of oxygen, 79 of azote, and about the one-half of a thousandth part of carbonic acid, with a very variable proportion of water diffused through it in the elastic state in the form of vapour, and when in the vesicular state in the form of clouds, and also an extremely minute portion, there is reason to believe of carbonate of ammonia, and of some other matters, chiefly saline, either held in solution in it or in suspension.

Rain, it is to be remembered, is never absolutely pure water: it is variously impregnated; and this in consequence of two offices which it seems to have to perform, (not to mention others); namely, the purifying of the atmosphere, and the fertilizing of the earth. Carbonic acid, oxygen, and azote, are always contained in it, and the former in considerably larger proportion than in the atmosphere, oxygen being more soluble in water than azote. And besides these, there are other matters, such as carbonate of ammonia, and various substances which it brings down with it, exercising its purifying function, from the atmosphere, in which they were suspended or dissolved.

The rain entering the soil thus impregnated, not only immediately promotes active vegetation, but also has an ameliorating effect on the soil and the subsoil, fitting it for the purposes of vegetation. The water, impregnated with oxygen, promotes the decomposition of animal and vegetable matter, thus forming food for plants; and acting on compound minerals in the soil and subsoil, it produces the separation of their elements; and thus forms new mould. Thorough-draining, by preventing the stagnation of water, and promoting its descent, administers in a remarkable manner to these ameliorating effects. And preserving the soil and subsoil in a porous condition, it administers also to another effect, not insignificant in the economy of vegetation, namely, the formation of ammonia by the union of the azote of the atmospheric air penetrating into the earth, with hydrogen, as it is disengaged from decomposing animal and vegetable matter; thus supplying an alkali, which appears to be the most active portion of many valuable manures, and is probably essential to the production in plants of all these albuminous substances which are of the nature of animal matter, from which even animals themselves—those feeding on vegetables, are supposed to be formed, the vegetable being the generator, and the animal only the recipient.

There are other good and important effects resulting from thorough-draining, which I have scarcely time to mention, as its tending to counteract the evils of drought, as well as of excessive moisture, thereby favouring vegetation, and at the same time benefiting the climate, as it conduces equally to prevent either extreme,—a parched state of the atmosphere, or excessive humidity and fog; and as it tends also to promote an equable temperature of atmosphere. In brief, it is difficult, I believe, to appreciate too highly the advantages of thorough-draining to land that requires it. Mr Smith of Deanston, who may be considered as the inventor of the process, has well said, that it requires *faith* to admit all the good it is capable of accomplishing,—that good is so much beyond what the inexperienced in its efficacy would expect.

I consider it, I may remark, a circumstance of good fortune to have witnessed the results of the first trial made of it at Deanston by this gentleman, and also the first attempt, I believe, of the kind made within the tropics, viz., in this island, by your talented countryman Dr Phillips, on his estate of Lamberts, and in Demerara by Dr Schier, the able agricultural chemist of that colony, on an estate in the neighbourhood of George Town. At Deanston, when I was there six years ago, the condition of the land and of the pastures was such as to excite admiration. Though the season was unusually dry, and fields adjoining the property were parched, in which rushes were growing, the Deanston meadows, similarly situated, were beautifully green, and in them not a rush was to be seen or a weed. The harvest was over, but the farmyard, in the numerous stacks of corn, bore ample proof of the great fertility of the arable land. The increased value of the estate, the result of its improvement from thorough-draining and good farming, I am afraid to mention, lest I should lay myself open to the charge of exaggeration. Mr Smith, who was my conductor and informant on the occasion, kindly had a hole dug through the soil and subsoil, to shew the deepening of the soil from the decomposition and disintegration of the subjacent stony matter from the action on it of air and moisture. In Demerara, the result of Dr Shier's experiment, making allowance for the shortness of time, appears to be no less satisfactory. When I saw the field, in the latter end of May last, after a heavy fall of rain, water was flowing abundantly from the mouths of the drains, whilst the surface soil was merely moist, and in a fit state for tillage; and having no open drains, such as are generally used in the colony, it was in a condition to admit of the plough and harrow, and the use of any other implement of husbandry likely to economise labour. In a letter with which I have been favoured by Dr Shier, of the 3d of November last, he makes mention of the thorough-drained field as in a very prosperous state. Canes grown in it, cut when only six months old, gave a juice of the specific gravity of 1·070; and an imperial gallon of this juice yielded 1 lb. 2 oz. of beautiful muscovado sugar, the molasses from which contained only about one-third as much salt as molasses from other fields of the estate with open drains. For the success of the experiments at Lamberts, in this island, we have the authority of the Leeward Agricultural Society. In their report, dated the 2d of last May, it is stated, that a field of $2\frac{1}{2}$ acres, which in wet seasons had always failed, drained in April 1846, did not suffer at any period of the late wet season; "whilst the field adjoining, although of somewhat greater elevation, suffered materially from the effects of water, making, on an average, one hogshead less per acre than the drained field, although manure had been applied to the former and not to the latter." And I have had confirmation of these favourable results, and I am glad to say, on an extended scale, from the resident manager on the estate, Mr Phillips. In a note with which he has obliged me, of the 1st of this month, he states, that 8 acres of land are now drained and planted, land similarly situated to that just mentioned as, before draining, liable to suffer from heavy rain, the bad effect of which it has entirely escaped this year, and that the canes on it are very superior to any on the estate. He adds, that there are now altogether 15 acres drained, and that he hopes to complete 20 acres before the end of the year. He specially notices, as worthy of remark, that, during the severe drought some months ago, the canes on the drained land suffered least; and, yet that the soil of this land, compared with any other, always appeared drier and more friable;—all results, let me observe, in accordance with the principle of thorough-draining, and the general experience we have of its effects.

I must not conclude the subject of draining, without briefly adverting to the qualities of soil which may be considered as requiring, and to the contrary ones not needing it. If the soil be sandy, or abounding in marl, with a sandy or marly subsoil, it will be sufficiently porous to water; water will not collect and stagnate on it, except, indeed, its situation be low, and almost on a level with the sea high water-mark. Moreover, if the soil be shallow, only 3 or 4 feet deep, resting on porous rock, such as the shell and coral limestone of Barbadoes commonly is, thorough-draining would be superfluous, could it be effected. Occasionally, however, and not unfrequently, this rock is covered with an adventitious incrustation of carbonate of lime, impervious equally to rain-water and the roots of plants. To give fertility to land so situated, this crust should be broken through, as I believe it sometimes is, preparatory to the planting of canes. In Malta, I may remark incidentally, where a like crust forms on the soft porous freestone on which the scanty soil of that island rests, from time to time the industrious natives bare the rock of its soil, and make grooves in it, penetrating through the hard incrustation, so as to admit the passage of rain-water into the rock, and its exhalation to the soil during the dry season. The qualities of soil likely to be benefited by thorough-draining, are the stiff clay soils, or the lighter and more porous soils, with a substratum of such clays on which, after heavy rain, water rests in a state of stagnation. Should it, as regards any soil, be a doubtful question whether it requires or not the process of thorough-draining, a simple experiment may be made, which may help to remove the doubt: it is by taking a portion of the soil, and subjecting it to the action of water in a tube, or a piece of bamboo covered at its lower end by linen, which will support the soil, and allow water to pass. If the soil, when compressed, acts in the manner of stiff clay, and does not allow the water to drop —to flow through it, it is a criterion of the propriety of draining; and the contrary, if it permit the passage of water. Trials of this kind, I apprehend, may be advantageously made to test the properties of soils, as to their retentive powers; which are graduated, in a great measure, by the proportion of alumine present, and the proportion of the other earths, in a finely-divided state,—any earth, if finely-divided, tending to have the same effect as alumine, in retarding or preventing the descent of water. The results of such trials, moreover, may indicate whether clay should be added to the soil to increase, or sand or lime to diminish, its power of retaining water.

I have spoken of Dr Shier's experiment on thorough-draining; let me add, what I should have done before, that you will find the particulars of it clearly detailed in his published report on thorough-draining, a report most highly creditable to him as a scientific agricultural chemist, and as a scientific inquirer, and which, for the valuable and new information it contains on the subject of which it treats, is particularly deserving the attention of all tropical agriculturists who wish to enter into the minute details of the operation. It affords a happy example of science and practice combined.

I remarked in commencing this discourse, that irrigation and thorough-draining are allied: they are so, not only inasmuch as water is mainly concerned in both, but also as to the manner in which it is concerned. Thorough-draining may be viewed as a slow and deep irrigation, the water descending from the surface to the drains or channels conveying away what is superfluous; whilst irrigation is the conducting of water over the surface of land in constant slow flow, so as to afford nourishment to the growing crop, which all experience proves it to do with wonderful effect. At the same time, it is to be kept in mind, that the slowly flowing water does not act merely superficially, but that it penetrates deeply; and not only promotes vegetation, but likewise, when properly managed, has a tendency to enrich the soil, either by what it deposits, or by its action, through the oxygen which it contains, occasioning the decomposition of mineral compounds in the soil and subsoil, and the setting free of inorganic substances, those required for the purposes of vegetation, such as the fixed alkalies, lime and magnesia, and certain acids, especially the phosphoric, which plants in the act of growing are constantly abstracting from the soil, by, if uncompensated, an exhausting process. The penetrating water, impregnated with oxygen, is also beneficial, in converting an injurious compound of iron, when present—the protoxide—into the inert and harmless peroxide, and likewise, and in a great degree, by favouring the decomposition of animal and vegetable matter, and the production of carbonic acid and ammonia. For these latter effects to be fully produced, the land should have the advantage of thorough-draining.

Water of various qualities is employed in irrigation, and, as might be anticipated, with an effect varying with the quality, that depending on the substances suspended or dissolved in the water. The purer the water, the less it will differ in its effect from rain. The more of decomposing animal and vegetable matter it contains, the more the effect will be like that of rich manure frequently applied, under the most favourable circumstances of season as to rain. The more of earthy matter it holds in suspension, in a finely-divided state —a state indeed necessary to suspension—the more its influence will resemble that of a well-watered virgin soil.

According to the kind of crop, water of irrigation, of one or the other of these qualities, appears to be preferable. The rice-lands of the mountainous parts of Ceylon yield, year after year, excellent produce, irrigated by water differing but little from rain water. The vineyards of Zante and Cephalonia, the fruit of which is the currant-grape, bear abundantly after a winter irrigation, the water used descending from the hills discoloured by clay, an argillaceous, calcareous marl, much resembling that deposited by the Nile, that vast irrigator and fertilizer of the ever-productive valley of Egypt. The meadows in the neighbourhood of Edinburgh, irrigated by the strongly impregnated sewer-water of that city, are well known for the enormous and repeated crops of grass they yield in the course of the year, almost without intermission.

The mode in which irrigation is performed is also various, depending very much on the scale. If for garden and limited field cultivation, in many countries the water used is raised from wells or cisterns by the Persian wheel, or by the lever and bucket, and distributed by little canals or gutters. If for extensive cultivation, streams are conducted from lakes or rivers, and their water admitted into prepared fields, and diffused over them. There are works for this purpose in India, tanks and aqueducts of immense magnitude, miles in circumference and length, which excite the wonder of the passing traveller, and are, in the labour expended on them, little inferior to the pyramids of Egypt themselves, it has been imagined, erected for hydraulic purposes. For every species of irrigation, I need hardly mention that there is one circumstance in common, which is, the making of the surface of the soil so gently inclined and regular, as to admit the flow of water over or through it uninterruptedly, with means of excluding the water when necessary.

Having stated thus much generally as to irrigation, I shall venture to make a few remarks on it, in connection with the cultivation of the sugar-cane, and the practicability of applying it far more generally than has hitherto been done to this the staple crop of these colonies. That irrigation is favourable to this crop, is, I believe, so well proved, that no doubt can be entertained respecting it. In this island, I understand, on one estate in St Phillip's, where the trial has been made, the success has been great; and that in periods of drought, when, without irrigation, the canes would hardly have been worth the reaping. In Berbice, there are one or two estates that I heard of when there, which had always been productive, yielding, even in the driest seasons, and always without the application of manure, not less than three hogsheads an acre, these estates having a command of water brought to them by an inland never-failing stream, derived by a canal from one of the large rivers of that country.

This partial success considered, and the nature of the cane, it being almost an aquatic plant, is it not deserving of thought, whether irrigation cannot be more generally applied, and whether all possible means, consistent with just economy, should not be taken to effect it, and even at intervals, and occasional, if means permitting it only at intervals be available?

In some parts of Barbadoes, especially in the parishes of St Joseph and St Andrew, and in that portion of St John's below "the Cliff," there are running streams, some of them perennial, in a great measure running to waste, which I have no doubt might be turned to the purposes of irrigation with excellent effect, especially if connected with terrace cultivation, which, in certain of the hill-sides, in these parishes where rock is in plenty, capable of affording stone for terrace walls of support, might be effected with no great labour and probably at a small expense. Such terraces are likely to have the double advantage of facilitating irrigation, and of preventing the soil from being washed away by heavy rains. Not only in the parishes named, but in most parts of the island, I imagine, partial irrigation might be accomplished, by forming channels in the cane-fields, to receive, after any considerable fall of rain, the running water in small streams, with such a declivity as to allow of their flowing slowly, remembering always that it is running water that promotes vegetation, and stagnant water only that injures it. Such small channels, after heavy rains, might also prove useful in preventing that accumulation of water, which occasions a destructive flood, that designated here, from its effects, "a wash."

Were thorough-draining introduced, the water in excess from a higher level, discharged by the drains, might be made applicable to partial irrigation in fields of a lower level. Such water, no doubt, would have a fertilising effect, and, perhaps, even more than ordinary rain-water, as it would contain certain saline substances and other compounds which are soluble, derived from the soil, and, it may be, from the manure in the soil, whilst the water is in the act of passing through it, and thus partaking of the quality of spring-water, which is always more or less impregnated with foreign matter, from a like cause, spring-water being rain-water that has passed through the natural filters of the earth's surface. Could this water be so applied to irrigation, it would remove an objection which may be started on the score of economy against thorough-draining,—an objection, however, I believe, of no great weight, if we place, as we should, against the loss by percolation, the gain by active vegetation kept vigorously so by moisture; and the gain to the soil, through the influence of thorough-draining of a decomposing and ameliorating kind, thereby adding to and deepening and improving it. The solvent power, however, of the percolating water is well worthy of being kept in mind; and it may raise a question of the propriety of applying largely manures to the soil at one time, and whether it would not be better, in the instances of the use of guano, nitrate of soda, and the like, to adopt the method said to be followed by the Peruvians, and make the applications in different stages of the crop, using smaller quantities.

Barbadoes in many respects resembles Malta; I am speaking of them now in their agricultural relations. In Malta, as I have already observed, there is a thin soil, which is of excellent quality, resting on a porous freestone. That island has a regular dry season, extending through the hot months of summer, and sometimes longer. Water there is a great want. To collect and store it, attention is constantly given, and immense labour has been expended. Not only every house has its tank, quarried in the rock, but also the majority of the fields—fields of terrace-construction called made-fields—" Campi artificiali." When the rains set in, even the public roads are made water-channels, and gutters from them convey the water into the field-tanks, some of which are excavated under the roads, and have mouths usually covered with large stones, even in the roads. When the dry season arrives, these tanks are brought into use. Water is raised from them by the lever and bucket, the simplest of all mechanical contrivances for the purpose, and applied to the watering of certain crops, as the cotton crop at a particular stage, and to various vegetables and fruit-trees. Could such reservoirs of water be introduced into Barbadoes, they would unquestionably be very useful, especially for the minor crops, and for garden cultivation. Of the happy effects of water applied to the latter, an instance offers, close to the garrison of St Ann's, where an intelligent and active Italian from Tuscany, has brought a piece of land, recently considered worthless, into the highest state of culture; and by the help of water from wells which he has sunk, and which, from their low situation, are never dry, he has succeeded in growing vegetables for the table throughout the year.

I must now, Gentlemen, bring this discourse to a conclusion. If I have occupied an undue portion of the time of the meeting, I must plead as an excuse the importance of the subjects treated of, which, even had I more time, I am conscious I could not have done justice to, and the peculiarity in relation to the agriculture of the colonies of the present period, and the prevailing impression, in consequence of this peculiarity, that your agriculture cannot continue to flourish, unless all possible means are taken to improve it. I allude to the free-trade measures which have become popular at home, and which have been carried out in part, and are likely to be extended, by Her Majesty's Government—measures which, if carried out in their true spirit, and liberally and rightly conducted, will assimilate, I cannot help thinking, *international trade* to the *home trade*, now allowed to be the most beneficial and the most profitable. Supposing, then, protection to colonial interests to be withdrawn, as is portended, and no discriminating duties allowed—a form of such protection—you will have to compete with thea griculturists of the world; not only with those of Hindostan and the far East, but what you seem to dread more, with those of Brazil, and the Spanish and French slave-colonies of the West Indies.

If I may venture to express an opinion, and I trust I may, as it is hopeful,—I cannot but think, if you put forth your energies, adopting every improvement that is economical, using implements as much as possible to spare human labour; paying well for what is employed, to encourage exertion and skill; and making an effort, which it is to be hoped will have encouragement from the Home Government, to improve your manufacturing processes; doing this, I cannot but think that you will be successful,—and that equally against the very cheap labour of the East Indies, and the slave-labour of the West. The one weak, and of little efficiency, so that it is rather cheap in name than in reality, and perhaps, better fitted for cotton than for the sugar-cane cultivation,—to which (the former) it appears probable, if the Navigation Laws be abrogated, it will soon be specially directed. The other forced, hardly to be depended on, and, as to cheapness and efficiency, even doubtful.

We have been told recently, that when the admission of slave-grown sugars into the English market was made known in Cuba, there were rejoicings and illuminations;—followed by excessive labour;—that the slaves during crop-time, in the boiling-houses, were kept constantly occupied fifteen hours in the twenty-four; and how, in the fields, they were kept to their task by the terror of the whips of the drivers,—these defended by blood-hounds; how, in accordance with this system, life is sacrificed there to work,—it being thought more profitable to make new purchases, than to take any care, entailing expense, of the labouring slaves; and this, although from 200 to 500 dollars is the market-price of a slave. Such particulars, and others of a horrid kind, we have from a writer, who has lately been in Cuba, he says, and, judging from the want of expression of feeling by him in giving the particulars, not averse to slave-labour; and therefore, probably, he has not exaggerated.

Such a system—such proceeding, may glut the home-market for a time; but can it be profitable long? surely not; a system connected with such monstrous vice, we may be confident cannot flourish. I should as soon expect that piracy would be successful for a continuance, and become an authorised calling. If it be profitable for the moment, depend upon it, it will meet with some great reverse, after the manner of piracy, as exemplified in the history of the Buccaneers, and with a punishment equal to the crimes that maintain it. Even without some signal visitation, I cannot believe that such a system can be long profitable,—when so high a price is paid for slaves,—and the period of their labour is so short, averaging, it is said, not more than ten years. And that it is not, seems to be denoted by these very colonies importing free labourers; and one of them, it is stated, even from China. But whether profitable or not, whether signally punished or not, this we are sure of—that man has a conscience, through which, even in this life, it cannot be doubted, that he is punished for his misdeeds, and rewarded for his good acts. In the ancient drama, the perpetrators of great crimes were held up to horror, as haunted by the avenging Furies, lashed by their whips of snakes and scorpions, and allowed no rest. These, in all times, are the stings of conscience, when awakened to a sense of guilt.

A President of the United States, Mr Jefferson, who, from his own experience, knew well the evils of slavery, and the dangers connected with it, alluding to these, has said:—"Indeed, I tremble for my country when I reflect that God is just, that his justice cannot sleep for ever; that considering numbers, nature, and natural means only, a revolution in the wheel of fortune, an exchange of situation, is among possible èvents; that it may become probable by supernatural interference! The Almighty has no attribute which can take side with us in such a contest."

Your success, Gentlemen, to which I have said, I look forward hopefully, if earned, as I expect, will be of the right kind, owing to your own exertions, without any strain on humanity, or violation of duty, beneficial to your labourers and the community at large; nor likely to be ephemeral, or soon to pass away; on the contrary to be stable, and to increase in amount with its endurance, which may be held to be characteristic of what is right, of which we have so many proofs in history, both ancient and modern, and remarkably so, as regards the converse, in the history of our own times, during the last half century, of which that of St Domingo alone may be held to be an epitome.

These few remarks, I trust you will receive with the indulgence I have been accustomed to have from you. They may appear foreign from my subjects; but, there are times when it seems a duty to express individual opinion, and raise the voice against what is monstrous. I have faith that the sentiments I have now expressed will have your approval and sympathy, and so received and approved, individual opinion acquires the character of public opinion, and carries with it its weight.

Apart from virtue and vice, right and wrong, it is a problem, merely economically considered, in the minds of many reflecting persons, which kind of labour is most profitable—slave or free labour. I trust, Gentlemen, it is your destiny to prove, and it will be a high destiny in regard to its probable consequences, that the free—the right labour, is truly that which makes, in the long run of time, the best return. And let this be but proved,—then, even amongst merely money-making men, slavery should fall, being without even a plausible support.

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*The Present Condition of the Indian Archipelago.**

Physical relation of the Archipelago to the Continent of Asia.—Hypothesis of their former connection.—Influence of its geological development on the distribution and form of the islands, on climate and vegetation.—Luxuriance of the latter, character thereby given to the small islands, to the mountains.—Change caused by volcanic eruptions.—Forests of the Archipelago, their character, wild animals.—The life of the sea-marshes, beaches, and banks.—Testimony of naturalists to the exuberance and beauty of animal and vegetable life.—Influence of the physical on the human history of the region,—population an extension of that of the continent.—Two great eras in its civil history.—Wild nomades of the forests and the sea.—Hindu civilization.—Mahomedan.—Rise of dominant nations.—European influence.—Great diversity of tribes, languages, customs, forms of government.—Human and life industry in the Archipelago at the present day.—Great piratical communities.—Slave trade.—Social and personal condition of the inhabitants.—Present degeneracy of the governments from the influence of the European dominations—foreign elements of change—means of amelioration—duty of England.

The first and most general consideration in a physical review of the Archipelago is its relation to the Continent of Asia. In the platform, on which the largest and most important lands are distributed, we see a great root which the stupendous mass of Asia has sent forth from its south-eastern side, and which, spreading far to the south beneath the waters of the Indian and Pacific Oceans, and there expanding and shooting up by its plutonic and volcanic energy,

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* As the *Journal of the Indian Archipelago*, already recommended to public attention in this Journal, has scarcely reached Europe, we have pleasure in laying before our readers part of an introductory memoir by the Editor.

has covered them, and marked its tract with innumerable islands. That there is a real and not merely a fanciful connection between the Archipelago and Asia is demonstrable, although, when we endeavour to trace its history, we are soon lost in the region of speculation. So obvious is this connection, that it has been a constant source of excitement to the imagination, which, in the traditions of the natives, and in the hypotheses of Europeans, has sought its origin in an earlier geographical unity. Certainly, if in the progress of the elevatory and depressing movements which the region is probably undergoing even now, the land were raised but a little, we should see shallow seas dried up, the mountain ranges of Sumatra, Borneo, and Java, become continental like those of the Peninsula, and great rivers flowing not only in the Straits of Malacca, whose current early navigators mistook for that of an inland stream, but through the wide valley of the China Sea, and by the deep and narrow Strait of Sunda, into the Indian Ocean. Thus the unity would become geographical, which is now only geological. That the great platform from which only mountains and hills rose above the sea-level, till the materials drawn from them by the rains were rolled out into the present alluvial plains, is really an extension of the Asiatic mass, appears evident from the facts, amongst many others which require a separate geological paper for their discussion, and would be less readily appreciated by the general reader, that its direction, as a whole, is that which a continuation of South-Eastern Asia, under the same plutonic action which produced it, would possess;—the mountain ranges, which form the latter, sink into it irregularly in the lines of their longitudinal axes;—in one zone, that of the Peninsula, the connection is an actual geographical one;—the Peninsula is obviously continued in the dense clusters of islands and rocks, stretching on the parallel of its elevation and of the strike of its sedimentary rocks from Singapore to Banka, and almost touches Sumatra, the mountain ranges of which are, notwithstanding, parallel to it;—Borneo and Celebes appear to represent the broader or eastern branch of the Indo-Chinese Peninsula, from which they are separated by the area of the China Sea, supposed to be sinking;—and, finally, nearly the whole Archipelago is surrounded by a great volcanic curve, rooted in Asia itself, and the continuity of which demonstrates that the platform and the continental projection with which it is geographically connected are really united at this day into one geological region by a still vigorous power of plutonic expansiveness, no longer, to appearance, forming hypogene elevations, but expending itself chiefly in the numerous volcanic vents along the borders where it sinks into the depths of the ocean.

Whether the present platform ever rose above the level of the sea and surrounded the new insular eminences with vast undulating plains of vegetation, instead of a level expanse of water, we shall not here seek to decide, although we think that Raffles, and others who have followed in his steps, too hastily connected the supposed subsidence with the existing geological configuration of the region, and neglected the all-important evidence of the comparative distribution of the living flora and fauna, which seems to prove that the ancient southern continent, if such there was, had subsided before they came into existence. No conclusive reasons have yet been adduced why we should consider the islands of the Archipelago as the summits of a partially submerged, instead of a partially emerged, continent. But whether it was the sinking of the continent that deluged all the southern lowlands of Asia, leaving only the mountain summits visible, or its elevation that was arrested by the exhaustion of the plutonic energy, or the conversion of its upheaving into an ejecting action, on the opening of fractures along the outskirts of the region, before the feebler action there had brought the sea-bed into contact with the atmosphere, the result has been to form an expanse of shallow seas and islands elsewhere unequalled in the world, but perhaps not greater in proportion to the wide continental shores, and the vast bulk of dry land in front of which it is spread out, than other archipelagoes are to the particular countries or continental sections with which they are connected.

The forms and positions of these islands bear an older date than that of any limited subsidence or elevation of the region after its formation. They were determined by the same forces which originally caused the platform itself to swell up above the deep floor of the southern ocean ; and it was one prolonged act of the subterranean power to raise the Himalayas into the aërial level of perpetual snow, to spread out the submarine bed on which the rivers were afterwards to pile the hot plains of Bengal, and to mould the surface of the southern region, so that when it rose above, or sunk into, the sea to certain levels, the mutual influences of air and sea and land should be so balanced, that while the last drew from the first a perennial ripeness and beauty of summer, it owed to the second a perennial freshness and fecundity of spring. Hence it is, that in the Archipelago, while the bank of black mud daily overflowed by the tides is hidden beneath a dense forest, and the polypifer has scarcely reared its tower to the sea's surface before it is converted into a green islet, the granitic rocks of the highest plutonic summits, and the smoke of the volcanic peaks, rise from amidst equally luxuriant and more varied vegetation. Certainly, the most powerfully impressive of all the characteristics of the Archipelago is its botanical exuberance, which has exercised the greatest influence on the history and habits of its human inhabitants, and which, as the most obvious, first excites the admiration of the voyager, and from its never staling, because ever renewing itself in fresh and changeful beauty, retains its hold upon our feelings to the last.

When we enter the seas of the Archipelago we are in a new world. Land and ocean are strangely intermingled. Great islands are dis-joined by narrow straits, which, in the case of those of Sunda, lead at once into the smooth waters and green level shores of the interior, from the rugged and turbulent outer coast, which would otherwise have opposed to us an unbroken wall more than two thousand miles in length. We pass from one mediterranean sea to another,—now through groups of islets so small that we encounter many in an hour, —and presently along the coasts of those so large that we might be months in circumnavigating them. Even in crossing the widest of the eastern seas, when the last green speck has sunk beneath the horizon, the mariner knows that a circle drawn with a radius of two days' sail would touch more land than water, and even that, if the eye were raised to a sufficient height, while the islands he had left would reappear on the one side, new shores would be seen on almost every other. But it is the wonderful freshness and greenness in which, go where he will, each new island is enveloped, that impresses itself on his senses as the great distinctive character of the region. The equinoctial warmth of the air, tempered and moistened by a constant evaporation, and purified by periodical winds, seems to be imbued with penetrating life-giving virtue, under the influence of which even the most barren rock becomes fertile. Hence, those groups of small islands which sometimes environ the larger ones like clusters of satellites, or mark where their ranges pursue their course beneath the sea, often appear, in particular states of the atmosphere, when a zone of white quivering light surrounds them and obliterates their coasts, to be dark umbrageous gardens floating on a wide lake, whose gleaming surface would be too dazzling were it not traversed by the shadows of the clouds, and covered by the breeze with an incessant play of light and shade. Far different from the placid beauty of such scenes is the effect of the mountain domes and peaks which elsewhere rise against the sky. In these the voyager sees the grandeur of European mountains repeated, but with all that is austere or savage transformed into softness and beauty. The snow and glaciers are replaced by a mighty forest, which fills every ravine with dark shade, and arrays every peak and ridge in glancing light. Even the peculiar beauties which the summits of the Alps borrow from the atmosphere, are sometimes displayed. The Swiss, gazing on the lofty and majestic form of a volcanic mountain, is astonished to behold, at the rising of the sun, the peaks inflamed with the same rose-red glow which the snowy summits of Mont Rosa and Mont Blanc reflect at its setting, and the smoke wreaths, as they ascend from the crater into mid air, shining in golden hues like the clouds of heaven.*

But, serene in their beauty and magnificence as these mountains generally appear, they hide in their bosoms elements of the highest terrestial sublimity and awe, compared with whose appalling energy,

* M. Zollinger, in describing Mount Semírú in Java, notices this singular resemblance to the mountains of his native country.

not only the bursten lakes and the rushing avalanches of the Alps, but the most devastating explosions of Vesuvius or Etna, cease to terrify the imagination. When we look upon the ordinary aspects of these mountains, it is almost impossible to believe the geological story of their origin, and if our senses yield to science, they tacitly revenge themselves by placing, in the remotest past, the era of such convulsions as it relates. But the nether powers, though imprisoned, are not subdued. The same telluric energy which piled the mountain from the ocean to the clouds, even while we gaze in silent worship on its glorious form, is silently gathering in its dark womb, and time speeds on to the day, whose coming science can neither foretell nor prevent, when the mountain is rent; the solid foundations of the whole region are shaken; the earth is opened to vomit forth destroying fires upon the living beings who dwell upon its surface, or closed to engulph them; the forests are deluged by lava, or withered by sulphurous vapours; the sun sets at noonday behind the black smoke which thickens over the sky, and spreads far and wide, raining ashes throughout a circuit hundreds of miles in diameter; till it seems to the superstitious native that the fiery abodes of the volcanic dewas are disembowelling themselves, possessing the earth, and blotting out the heavens. The living remnants of the generation whose doom it was to inhabit Sumbawa in 1815, could tell us that this picture is but a faint transcript of the reality, and that our imagination can never conceive the dreadful spectacle which still appals their memories. Fortunately, these awful explosions of the earth, which to man convert nature into the supernatural, occur at rare intervals; and, though scarcely a year elapses without some volcano bursting into action, the greater portion of the Archipelago being more than once shaken, and even the ancient granitic floor of the Peninsula trembling beneath us, this terrestrial instability has ordinarily no worse effect than to dispel the illusion that we tread upon a solid globe, to convert the physical romance of geological history into the familiar associations of our own lives, and to unite the events of the passing hour with those which first fitted the world for the habitation of man.

We have spoken of the impression which the exterior beauty of the Archipelago makes upon the voyager, and the fearful change which sometimes comes over it, when the sea around him is hidden beneath floating ashes mingled with the charred wrecks of the noble forests which had clothed the mountain sides; but, hurried though we are from one part of our slight sketch to another, we cannot leave the vegetation of this great region without looking upon it more closely. To recall the full charms, however, of the forests of the Archipelago—which is to speak of the Archipelago itself, for the greater portion of it is at this moment, as the whole of it once was, clothed to the water's edge with trees—we must animate their solitudes with the tribes which dwell there in freedom, ranging through their boundless shade as unconscious of the presence of man, and as unwitting of his dominion as they were thousands of years ago, when he did not dream that the world held such lands and such creatures.

When we pass from the open sea of the Archipelago into the deep shade of its mountain-forests, we have realised all that, in Europe, our fancies ever pictured of the wildness and beauty of primeval nature. Trees of gigantic forms and exuberant foliage rise on every side: each species shooting up its trunk to its utmost measure of development, and striving, as it seems, to escape from the dense crowd. Others, as if no room were left for them to grow in the ordinary way, emulate the shapes and motions of serpents, enwrap their less pliant neighbours in their folds, twine their branches into one connected canopy, or hang down,—here, loose and swaying in the air, or in festoons from tree to tree,—and there, stiff and rooted, like the yards which support the mast of a ship. No sooner has decay diminished the green array of a branch, than its place is supplied by epiphites, chiefly fragrant orchidaceæ, of singular and beautiful forms. While the eye in vain seeks to familiarise itself with the exuberance and diversity of the forest vegetation, the ear drinks in the sounds of life which break the silence and deepen the solitude. Of these, while the interrupted notes of birds, loud or low, rapid or long-drawn, cheerful or plaintive, and ranging over a greater or less musical compass, are the most pleasing, the most constant are those of insects, which sometimes rise into a shrill and deafening clangour; and the most impressive, and those which bring out all the wildness and loneliness of the scene, are the prolonged complaining cries of the únkas, which rise, loud and more loud, till the twilight air is filled with the clear, powerful, and melancholy sounds. As we penetrate deeper into the forest, its animals,—few at any one place,—are soon seen to be, in reality, numerous and varied. Green and harmless snakes hang like tender branches. Others of deeper and mingled colours, but less innocuous, lie coiled up, or, disturbed by the human intruder, assume an angry and dangerous look, but glide out of sight. Insects in their shapes and hues imitate leaves, twigs, and flowers. Monkeys, of all sizes and colours, spring from branch to branch, or, in long trains, rapidly steal up the trunks. Deer, and amongst them the graceful palandoh, no bigger than a hare, and celebrated in Malayan poetry, on our approach fly startled from the pools which they and the wild hog most frequent. Lively squirrels, of different species, are everywhere met with. Amongst a great variety of other remarkable animals which range the forests, we may, according to our locality, encounter herds of elephants, the rhinoceros, tigers, the tapir, the bábírúsa, the orangútan, the sloth; and, of the winged tribes, the gorgeously beautiful birds of paradise, the loris, the peacock, and the argus pheasant. The mangrove rivers and creeks are haunted by huge alligators. An endless variety of fragile and richly-coloured shells not only lie empty on the sandy beaches, but are tenanted by pagurian crabs, which, in clusters, batten on every morsel of fat sea-weed that has been left by the retiring waves. The coasts are fringed with living rocks of beautiful colours, and shaped like stars, flowers, bushes, and other symmetrical forms. Of multitudes of peculiar animals which inhabit the seas, the dugong, or Malayan mermaid, most attracts our wonder.

Before we leave this part of our subject, we would assure any European reader who may suspect that we have in aught written too warmly of the physical beauty of the Archipelago, that the same Nature which, in the west, only reveals her highest and most prodigal terrestrial beauty to the imagination of the poet, has here ungirdled herself, and given her wild and glowing charms, in all their fulness, to the eye of day. The ideal has here passed into the real. The few botanists who have visited this region declare, that from the multitude of its noble trees, odorous and beautiful flowers, and wonderful vegetable forms of all sorts, it is inconceivable in its magnificence, luxuriance, and variety. The zoologists, in their turn, bear testimony to the rare, curious, varied, and important animals which inhabit it, and the number and character of those already known is such as to justify one of the most distinguished of the day in expressing his belief, that "no region on the face of the earth would furnish more novel, splendid, or extraordinary forms than the unexplored islands in the eastern range of the Indian Archipelago."

Hitherto we have faintly traced the permanent influence of the physical configuration of the Archipelago in tempering the intertropical heat, regulating the monsoons, determining the distribution of plants and animals, and giving to the whole region its peculiar character of softness and exuberant beauty. But when its rock foundations were laid, the shadow of its future human as well as natural history spread over them. Its primal physical architecture, in diminishing the extent of dry land, has increased the variety in the races who inhabit it; while the mineralogical constitution of the insulated elevations, the manner in which they are dispersed throughout its seas, and all the meteoric and botanical consequences, have affected them in innumerable modes. Again, as we saw that the platform of the Archipelago is but an extension of the great central mass of Asia, and that the direction of the subterranean forces had determined the ranges of the land, so we find that its population is but an extension of the Asiatic families, and that the direction of migration was marked out by the same forces. But, separated by the sea from the great plains and valleys of the continent, having the grand routes of communication covered by mountains and dense and difficultly penetrable forest, the Archipelago could not be peopled by hordes, but must have owed its aborigines to the occasional wandering of small parties or single families. The migrations from one island to another were probably equally limited and accidental; and the small and scattered communities in such as were inhabited, must, for a long period, have remained secluded from all others, save when a repetition of similar accidents added a few more units to the human denizens of the forests.

We cannot here attempt to retrace in the most concise manner the deeply interesting history of the tribes of the Archipelago, so exciting from the variety of its elements, and its frequent, though not impenetrable, mystery. We can but distinguish the two great eras into which it divides itself,—that, at the commencement of which some of the inhabitants of the table-land of Asia, having slowly traversed the south-eastern valleys and ranges, a work perhaps of centuries, appeared on the confines of the Archipelago, no longer nomades of the plains but of the jungles, with all the changes in ideas, habits, and language which such transformation implies, and prepared by their habits to give rise, under the influences of their new position, to the nomades of the sea;—and the second era, that, at the commencement of which the forest and pelagic nomades, scattered over the interior, and along the shores, of the islands of the Archipelago, in numerous petty tribes, each with some peculiarities in its habits and language, but all bearing a family resemblance, were discovered in their solitudes by the earliest navigators from the civilized nations of the continent.

The ensuing, or what, although extending over a period of about two thousand years, we may term the modern history of the Archipelago, first exhibits the Klings from southern India,—who were a civilized maritime people probably three thousand years ago,—frequenting the islands for their peculiar productions, awakening a taste for their manufactures in the inhabitants, settling amongst them, introducing their arts and religion partially communicating these and a little of their manners and habits to their disciples, but neither by much intermarriage altering their general physical character, nor by moral influence obliterating their ancient superstitions, their comparative simplicity and robustness of character, and their freedom from the effeminate vanity which probably then, as in later times, distinguished their teachers. At a comparatively recent period, Islamism supplanted Hinduism in most of the communities which had grown up under the influence of the latter, but it had still less modifying operation; and, amongst the great bulk of the people, the conversion from a semi-Hindu condition to that of Mahomedanism was merely formal. Their intellects, essentially simple, and impatient of discipline and abstract contemplation, could as little appreciate the scholastic refinements of the one religion, as the complex and elaborate mythological machinery and psychological subtleties of the other. While the Malay of the nineteenth century exhibits in his manner, and in many of his formal usages and habits, the influence which Indians and Arabs have exerted on his race, he remains, physically and morally, in all the broader and deeper traits of nature, what he was when he first entered the Archipelago; and even on his manners, usages, and habits, influenced as they have been, his distinctive original character is still very obviously impressed.

We cannot do more than allude to the growth of population and civilization in those localities which, from their extent of fertile soil or favourable commercial position, rose into eminence, and became the seats of powerful nations. But it must be borne in mind that, although these localities were varied and wide-spread, they occupied but a small portion of the entire surface of the Archipelago, and that the remainder continued to be thinly inhabited by uncivilized tribes, communities, or wandering families.

Prevented, until a very recent date, by stubborn prejudices and an overweening sense of superiority, from understanding and influencing the people of the Archipelago, the European dominations have not directly affected them at all; and the indirect operation of the new power, and mercantile and political policies which they introduced, has been productive of much evil and very little good. While, on the one hand, the native industry and trade have been stimulated by increased demand and by the freedom enjoyed in the English ports, they have, on the other hand, been subjected by the Portuguese, English, and Dutch, to a series of despotic restraints, extending over a period of three hundred years: and, within the range of the last nation's influence, continued, however modified, to this hour: which far more than counterbalance all the advantages that can be placed in the opposite scale.

The effect of the successive immigrations, revolutions, and admixtures, which we have indicated or alluded to, has been that there are now in the Archipelago an extraordinary number of races, differing in colour, habits, civilization, and language, and living under forms of government and laws, or customs, exhibiting the greatest variety. The same cause which isolated the aborigines into numerous distinct tribes and kept them separate,—the exuberant vegetation of the islands,—has resisted the influence, so far as it was originally amalgamating, of every successive foreign civilization that has dominated; and the aboriginal nomades of the jungle and the sea, in their unchanged habits and mode of life, reveal to their European contemporary the condition of their race, at a time when his own forefathers were as rude, and far more savage. The more civilized races, after attaining a certain measure of advancement, have been separated by their acquired habits from the unaltered races, and have too often turned their superiority into the means of oppressing, and thereby more completely imprisoning in the barbarism of the jungles, such of them as lived in their proximity. So great is the diversity of tribes, that if a dry catalogue of names suited the purpose of this sketch, we could not afford space to enumerate them.

But, viewing human life in the Archipelago as a general contemplation, we may recall a few of the broader peculiarities which would be most likely to dwell on the memory after leaving the region.

In the hearts of the forests we meet man scantily covered with the bark of a tree, and living on wild fruits, which he seeks with the agility of the monkey, and wild animals, which he tracks with the keen eye and scent of a beast of prey, and slays with a poisoned arrow, projected from a hollow bambú, by his breath. In lonely creeks and straits we see him in a small boat, which is his cradle, his house, and his bed of death; which gives him all the shelter he ever needs, and enables him to seize the food which always surrounds him. On plains, and on the banks of rivers, we see the civilised planter converting the moist flats into rice-fields, overshadowing his neat cottage of bambú, nibong, aud palm-leaves, with the graceful and bounteous cocoa-nut, and surrounding it with fruits, the variety and flavour of which European luxury might envy, and often with fragrant flowering trees and shrubs which the greenhouses of the West do not possess. Where the land is not adapted for wet rice, he pursues a system of husbandry which the farmer of Europe would view with astonishment. Too indolent to collect fertilising appliances, and well aware that the soil will not yield two successive crops of rice, he takes but one, after having felled and burned the forest; and he then leaves nature, during a ten years fallow, to accumulate manure for his second crop in the vegetable matter elaborated by the new forest that springs up. Relieved from the care of his crop he searches the forests for ratans, canes, timber, fragrant woods, oils, wax, gums, caoutchouc, gutta-percha, dyes, camphor, wild nutmeg, tbe tusks of the elephant, the horn and hide of the rhinoceros, the skin of the tiger, parrots, birds of paradise, argus pheasants, and materials for mats, roofs, baskets, and receptacles of various kinds. If he lives near the coast, he collects fish, fish-maws, fish-roes, slugs (trepang), sea-weed (agaragar), tortoise-shell, rare corals, and mother of pearl. To the eastward, great fishing voyages are annually made to the shores of Australia for trepang. In many parts, pepper, coffee, or betel-nut, to a large, and tobacco, ginger, and other articles, to a considerable extent, are cultivated. Where the hirundo esculenta is found, the rocks are climbed and the caves explored for its costly edible nest. In different parts of the Archipelago the soil is dug for tin, antimony, iron, gold, or diamonds. The more civilised nations make cloths and weapons, not only for their own use but for exportation. The traders, including the Rajahs, purchase the commodities which we have mentioned, dispose of them to the European, Chinese, Arab, or Kling navigator who visits their shores, or send them in their own vessels to the markets of Singapore, Batavia, Samarang, Manilla, and Maccassar. In these aro gathered all the products of the Archipelago, whether such as the native inhabitants procure by their unassisted industry, or such as demand the skill and capital of the European or Chinese for their cultivation or manufacture; and, amongst the latter, nutmegs, cloves, sugar, indigo, sago, gambier, tea, and the partially cultivated cinnamon and cotton. To these busy marts, the vessels of the first maritime people of the Archipelago, the Bugis, and those of many Malayan communities, bring the produce of their own countries, and that which they have collected from neighbouring lands, or from the wild tribes, to furnish cargoes for the ships of Europe, America, Arabia, India, Siam, China, and Australia. To the bazar of the Eastern seas, commerce brings representatives of every industrious nation of the Archipelago, and of every maritime people in the civilised world.

Although, therefore, cultivation has made comparatively little impression on the vast natural vegetation, and the inhabitants are devoid of that unremitting laboriousness which distinguish the Chinese and European, the Archipelago, in its industrial aspect, presents an animated and varied scene. The industry of man, when civilisation or over-population has not destroyed the natural balance of life, must ever be the complement of the bounty of nature. The inhabitant of the Archipelago is as energetic and laborious as nature requires him to be; and he does not convert the world into a workshop, as the Chinese and the Kling immigrants do, because his world is not, like theirs, darkened with the pressure of crowded population and over-competition, nor is his desire to accumulate wealth excited and goaded by the contrast of splendour and luxury on the one hand, and penury on the other,—by the pride and assumptions of wealth and station, and the humiliations of poverty and dependence.

While in the volcanic soils of Java, Menangkabau and Celebes, and many other parts of the Archipelago, population has increased, au industry suited to the locality and habits of each people prevails, and distinct civilisations, on the peculiar features of which we cannot touch, have been nurtured and developed; other islands, less favoured by nature, or under the influence of particular historical circumstances, have become the seats of great piratical communities, which periodically send forth large fleets to sweep the seas, and lurk along the shores, of the Archipelago, despoiling the seafaring trader of the fruits of his industry and his personal liberty, and carrying off, from their very homes, the wives and children of the villagers. From the creeks and rivers of Borneo and Johore, from the numerous islands between Singapore and Banka, and from other parts of the Archipelago, piratical expeditions less formidable than those of the Lanuns of Sulu are year after year fitted out. No coast is so thickly peopled, and no harbour so well protected, as to be secure from all molestation, for, where open force would be useless, recourse is had to stealth and stratagem. Men have been kidnapped in broad day in the harbours of Pinang and Singapore. Several inhabitants of Province Wellesley, who had been carried away from their houses through the harbour of Pinang and down the Straits of Malacca to the southward, were recently discovered by the Dutch authorities living in a state of slavery, and restored to their homes. But the ordinary abodes of the pirates themselves are not always at a distance from the European settlements. As the thug of Bengal is only known in his own village as a peaceful peasant, so the pirate, when not absent on an expedition, appears in the river, and along the shores and islands of Singapore, as an honest boatman or fisherman.

When we turn from this brief review of the industry of the Archipelago, and its great internal enemy, to the personal and social condition of the inhabitants, we are struck by the mixture of simplicity and art, of rudeness and refinement, which characterises all the principal nations. No European has ever entered into free and kindly intercourse with them, without being much more impressed by their virtues than their faults. They contrast most favourably with the Chinese and the Klings in their moral characters; and although they do not, like those pliant races, readily adapt themselves to the requirements of foreigners, in their proper sphere they are intelligent, shrewd, active, and, when need is, laborious. Comparing them even with the general condition of many civilized nations of far higher pretensions, our estimate must be favourable. Their manners are distinguished by a mixture of courtesy and freedom which is very attractive. Even the poorest while frank are well bred, and, excluding the communities that are corrupted by piracy, or a mixture with European seaman and low Chinese and Klings, we never see an impudent air, an insolent look, or any exhibition of immodesty, or hear coarse, abusive, or indecent language. In their mutual intercourse they are respectful, and, while good-humoured and open, habitually reflective and considerate. They are much given to amusements of various kinds, fond of music, poetry, and romances; and in their common conversation addicted to sententious remarks, proverbs, and metrical sentiments or allusions. To the first impression of the European, the inhabitants, like the vegetation and animals of the Archipelago, are altogether strange; because the characteristics in which they differ from those to which we are habituated, affect the senses more vividly than those in which they agree. For a time the colour, features, dress, manners, and habits which we see, and the languages which we hear, are those of a new world. But with the fresh charms, the exaggerated impressions also of novelty wear away; and then, retracing our steps, we wonder that people so widely separated from the nations of the west, both geographically and historically, and really differing so much in their outward aspect, should, in their more latent traits, so much resemble them. The nearer we come to the inner spirit of humanity, the more points of agreement appear, and this not merely in the possession of the universal attributes of human nature, but in specific habits, usages, and superstitions.

What at first seems stranger still is, that when we seek the native of the Archipelago in the mountains of the interior, where he has lived for probably more than two thousand years secluded from all foreign influence, and where we expect to find all the differences at their maximum, we are sometimes astonished to find him approximating most closely of all to the European. In the Jakún, for instance, girded though his loins are with *terap* bark, and armed as he is with his sumpitan and poisoned arrows, we recognise the plain and clownish manners, and simple ideas of the uneducated peasant in the more secluded parts of European countries; and when he describes how, at his merry-makings, his neighbours assemble, the arrack tampúí flows around, and the dance, in which both sexes mingle, is prolonged, till each seats himself on the ground with his partner on his knee and his bambn of arrack by his side, when the dance gives place to song, we are forcibly reminded of the free and jovial, if rude, manners of the lower rural classes of the west. Freed from the repellant prejudices and artificial trappings of Hindu and Mahomedan civilisation, we see in the man of the Archipelago more that is akin than the reverse to the unpolished man of Europe.

When we turn to the present political condition of the Archipelago, we are struck by the contrast which it presents to that which characterised it three or four centuries ago. The mass of the people, it is true, in all their private relations, remain in nearly the same state in which they were found by the earliest European voyagers, and in which they had existed for many centuries previously. But, as nations, they have withered in the presence of the uncongenial, greedy, and relentless spirit of European policy. They have been subdued by the hard and determined will of Europeans, who, in general, have pursued the purposes for which they have come into the Archipelago, without giving any sympathy to the inhabitants. The nomadic spirit, never extinguished during all the changes which they underwent, had made them adventurous and warlike when they rose into nations. But now, long overawed and restrained by the power of Europeans, the national habits of action have, in most parts of the Archipelago, been lost, or are only faintly maintained in the piratical expeditions of some. Their pride has fallen. Their living literature is gone, with the power, the wars, and the glory which inspired it. The day has departed when Singapore could be invaded by Javanese,—when Johore could extend its dominion to Borneo on the one side, and Sumatra on the other,—when the fleets of Acheen and Malacca could encounter each other in the straits, to dispute the dominion of the eastern seas,—when the warrants of the Sultan of Menangkabaú were as potent over the Malayan nations as the bulls of Rome ever were over those of Christendom,—when a champion of Malacca could make his name be known all over the Archipelago,—and when the kings of the Peninsula sent their sons, escorted by celebrated warriors, to demand the daughters of the emperors of Majapahit in marriage. The Malayan princes of the present day retaining all the feudal attachment and homage of their subjects, and finding no more honourable vent for the assertion of their freedom from restraint and the gratification of their self-will, have almost everywhere sunk into indolent debauchees and greedy monopolists, and, incited by their own rapacity and that of the courtiers who surround them, drain and paralyse the industry of their people.

The foreign elements at present exercising, or likely to exercise, great influence on the condition of the Archipelago, are the dominion of the Dutch and Spanish, the commerce and settlements of the English, the educational and missionary efforts of Christendom, the growth of large Chinese communities, and the continued influx of emigrants from China. It is probable, if England does not extend her influence, that the whole Archipelago, with the exception of the Malayan Peninsula (which is always considered a member of it), the Philippines, and a small portion of Borneo, will, in no long time, become a portion of the Dutch empire; and if the humanising and liberal influences which, we hope, are now modifying the character of the eastern policy of that nation, receive full effect, and Netherlands India comes to be really looked upon as an integral part of Holland, its inhabitants being admitted to a full reciprocity of advantages with those of the European portion of the empire, there will be little to regret, and much to welcome, in the change. England, in introducing freedom of trade, and in leaving the inhabitants and their possessions, small as they are, to the unshackled exercise of their own industry, has set an example of rational government which, if imitated in every European possession in the Archipelago, would do something to atone for past misgovernment and neglect. It is impossible to foresee how great the influence of the Chinese may become. Large as the Chinese population already is, and numerous as the annual emigrants from China are, they must, in the progress of the change which is working in China itself, greatly increase; and there can be little hazard in looking to the pressure of population in China, as one of the most momentous elements in the future history of the Archipelago.

Broken down as the more civilised and once powerful states are, till their governments, with hardly an exception, have lost all the energy and ambition to be useful, and retain only the power to be hurtful; divided as the greater proportion of the population of the Archipelago is, into separate tribes and communities too small to resist the domineering and exacting spirit of the more covetous, bold, and active Malays and Bugis who infest their coasts; openly robbed and enslaved by their brother islanders; defrauded by the Chinese, Kling, or Arab adventurer, whose superior activity and cunning enable him to profit more by their industry than they do themselves; neglected by the European who seeks the same end by honest means, and, that attained, returns to his native country, and gives them no second thought; and without any active internal elements of advancement;—it is only by awakening an interest in Europe itself that the inabitants of the Archipelago can hope for any amelioration. So long as they only know one phase of European character,—the ardent, steady, and inventive pursuit of gain,—the influence of Europe will remain, what it has hitherto proved, more prejudicial than beneficial. But let the deep human sympathy which dwells in England, and overflows on so many sides, once effectually reach the people of this noble region of the world; let England learn their many virtues, their mild and engaging manners, their freedom from intolerance, their docility, their aptitude for instruction; and let her but take seriously to heart the fact that on the seas where her flag has floated, and her commerce largely profited for two hundred and fifty years, the peaceful trader cannot at this day venture to embark without the risk of being slain or enslaved,—that from the destruction of all national power, in which her own policy aided, a few thousand pirates now keep the coasts of countries numbering millions of inhabitants in a state of insecurity,—and her energy and resources will soon work out the best means of suppressing these evils at once and for ever, and of implanting fresh and vigorous elements of moral development in the now stagnant minds of the inhabitants. Without this we may continue for another hundred years to mingle in the trading communities of the Archipelago, without ever exercising any of that influence which our predecessors, the Hindus and the Mahomedans, exercised. But if we would seek to assimilate the natives of the Archipelago to those of Europe, and take them with us on our path of advancement, we must, like the Hindus and Mahomedans, begin by acquiring a thorough and familiar knowledge of them.

Their political and material wants are so connected, that whatever tends to remedy the latter must react on the former. It is no less the duty of the Christian and the philanthropist for their ends, than of the economist for his, to take every practicable measure for the improvement of the external condition of the natives of the Archipelago. We need not now suffer our minds to be disturbed by any misgivings as to the benefit derivable from European influence. In the first place, the influence hitherto has not been that of Europe in her noblest characteristics; or the lower and more selfish have so much predominated, that they have not yet dreamt of Europe in her earnest devotion to the bettering of humanity, her pure and deep love of all truth, spiritual and physical, and her ever-extending knowledge of the secret springs of nature. For, although we fully appreciate the earnest and noble labours of the missionaries who are found in many of the islands, we cannot be blind to the fact, that their numbers and resources are, as yet, far too limited to make more than a slight impression on the great field which lies around them. In the second place, we have no choice. We may deplore that some tribes, happy in their simplicity and guilelessness, should be roused from their repose of peace, to pass through the turbulent period which separates man, first awaking to a sense of new wants, and setting out on his career of dissatisfaction and action, from man, when civilisation has thrown off its early vices and evils, and is bringing all human wants and desires into harmony. But we cannot, if we would, arrest the march of events; and as the necessities and enterprise of China and Europe are yearly more and more invading the recesses of the Archipelago, and the most secluded tribes must in a short time be brought within the circle of general economical intercourse, we must dismiss from our minds distrust and hesitation, and substitute in their place the fact that this intercourse is now most extensive, will soon be universal, and is a mighty agent for good as well as for evil.

Unfortunately the Chinese, who are so rapidly spreading, can only corrupt and debase the natives. Living but for gain and merely physical enjoyment, and pursuing these objects with a combination of the most mature patience, laboriousness, duplicity, craft, and often fraud, which is the more dangerous from the easy, open, plain, and plausible manner with which it is accompanied, the Chinese flow into every opening which European powers effect, whether by supplanting or weakening native governments. If every step which European enterprise makes is thus followed by an accession of Chinese corruption, it is the more incumbent on Europe that she no longer stand aloof from the natives, and abandon them to the debasement of a civilisation, purely industrial and sensual, to which she contributes to expose them.

It is time that England should see and be shocked by the effects of her past policy, or absence of policy, in the anarchy, degeneracy, oppressions, and vices, which largely prevail in many parts of the Archipelago. England would then learn by what a small effort, in comparison with those which she is daily making for objects of far inferior magnitude and moment, she might make herself known in her true character in the Archipelago, and speedily free the slave from his bonds; suppress the trade in men, and its associate, piracy; mitigate and eventually abolish the heavy monopolies and restraints which depress industry, and nourish oppression, fraud, and corruption: and, having thus given to the people freedom in person, property, and mind, lead them, through her sympathy and pity, and their docility and gratitude, to a willing reception of the humanising and elevating knowledge of Christendom.

On Mineral Metamorphism.

As the doctrine of mineral metamorphism is now exciting very general attention, we, as introductory to what we may afterwards communicate on this important and curious subject, lay before our readers a few explanatory observations by one of the most distinguished of modern geologists — the celebrated Swiss philosopher and professor, B. Studer.*

Metamorphism, Definition.

In its wider sense, mineral metamorphism means every change of aggregation, structure, or chemical condition which rocks have undergone subsequently to their deposition and stratification, or the effects which have been produced by other forces than gravity and cohesion. There fall under this definition :—the discoloration of the surface of black limestone by the loss of carbon ; the formation of brownish-red crusts on rocks of limestone, sandstone, many slatestones, serpentine, granite, and so on, by the decomposition of iron pyrites, or magnetic iron, finely disseminated in the mass of the rock ; the conversion of anhydrite into gypsum, in consequence of the absorption of water ; the crumbling of many granites and porphyries into gravel, occasioned by the decomposition of the mica or felspar. In this doctrine must also be reckoned the conversion of water into ice, and of snow and ice into water, or into steam. In its more limited sense the term metamorphic is confined to those changes of the rock which are produced, not by the effect of the atmosphere or of water on the exposed surfaces, but which are produced, directly or indirectly, by agencies seated in the interior of the earth. In many cases the mode of change may be explained by our physical or chemical theories, and may be viewed as the effect of temperature, or of electro-chemical actions. Adjoining rocks, or connecting communications with the interior of the earth, also distinctly point out the seat from which the

* Vide Lehrbuch der Physikalchen Geographie und Geologie, vol. 2. Bern, 1847.

change proceeds. In many other cases the metamorphic process itself remains a mystery, and from the nature of the products alone do we conclude that such a metamorphic process has actually taken place ; as, for instance, when we find neptunian rocks gradually passing into others, which, to judge from their present condition, could not have been formed in water. Geological science is in the same position in reference to metamorphic rocks, as mineralogy is with reference to the pseudomorphic crystals : it acknowledges the change to be a fact established by accurate observation, but by no means depending on the probability or possibility of an explanation.

Metamorphosis of Rocks by Heat and Cementation.

The influence exercised by quick or slow cooling, the pressure which keeps gases in their combinations, and the effect which is thus exercised upon the aggregation and structure of the solidifying fused masses, has already been mentioned.* Also, regarding the change of stratified neptunian rocks by heat, a multitude of facts have, in later times, been collected, partly by direct observation of the effect of the furnace-fires on the bricks of the furnace, or of burning beds of coal on the adjacent strata ; and partly indirectly, by concluding that this effect exists from the changes which such neptunian rocks shew in the neighbourhood of others, of which, it is supposed, they were at one time in a state of fusion, or had, at least, been strongly heated, that is to say (*i.e.*) we reason from the *relations of contact.* Metallurgical processes have shewn that the chemical condition of solid substances, when exposed to high temperatures, may undergo alterations without previous fusion. In the process of cementation, iron, when nealed for some time with pounded charcoal, unites with the charcoal and forms steel ; so also copper, when nealed with zinc, is changed into brass. In Agordo and Röraas, pyrites, containing only 2 per cent. of copper, when roasted in pieces the size of a fist, become changed in the centre into copper pyrites, yielding 7 per cent. pure copper, and this central mass detaches itself with a smooth variegated surface,

* Vide vol. i. p. 136 of Studer's Lehrbuch.

from the external, nearly copperless exterior. In South America, gold, containing silver, is reduced to almost pure gold, when the grains are nealed with brick-dust and culinary salt; the silica, assisted by the watery vapours issuing from the fuel, decomposes the muriate of soda, when muriatic acid is evolved, and the chlorine unites with the silver to form chloride of silver. In more recent times, there have been produced, by direct smelting experiments, or as casual productions of the forge, many minerals which most frequently belong to the volcanic and metamorphic rocks. Augite, a principal ingredient of many lavas and traps, was discovered in the slags of Fahlun. The slags of Sahla are deceptively like basalts, and their cavities are occupied by augite crystals. By fusion of the ingredients of augite, Berthier and Mitscherlich obtained distinct crystals of augite. A mineral isomorphic with olivin, a common ingredient of basalt, is not unfrequently contained in the slags of the iron-refining and copper-smelting processes. Felspar was found in the shape of distinct crystals, possibly formed from vapours (Hausmann) in the rents of a copper-furnace at Sangershansen, in the district of Mansfeld. At Stolberg, on the Hartz Mountains, small twin crystals, exactly similar to the adularia of Mont Gotthard, were found in a deserted iron-furnace $5\frac{2}{3}$ feet above the floor (Hausmann). A direct formation of felspar has never yet been obtained by the fusing together of its ingredients. Mitscherlich met with mica in the form of hexagonal prisms, in the old slags of a copper-melting furnace in Sweden. Hausmann met with scales nearly related to mica, in the cells of a crystalline sandstone which had served in the Hartz as the floor or bottom of an iron-furnace. Garnets and Idocrases have partly been produced from their ingredients by smelting, and have partly been found in the slags of furnaces. A crystalline substance, resembling the mineral named Wollastonite, was discovered in iron slags. Gaudin made crystals of corundum by artificial means. The metamorphosis of many rocks, which have been mentioned as abnormal or older limestones, clays, sandstones, and coals, rests on these facts and others yet to be quoted; although, in many cases, we should be at a loss to explain the act of metamorphosis and the productions of new minerals by the effect of heat on the individual cases.

The distance to which the metamorphic influence of heat extends, or the thickness of the metamorphosed portions of the rock which separates the original rock from the eruptive mass, is very unequal. The influence of the trap veins or dikes on the adjoining rock, and even of the great overlaying trap upon the subjacent rock, seldom extends beyond a few fathoms. On the Krazzenberg, near Cassel, the shell-limestone (muschelhalk) has been altered to the extent of one foot from a basaltic vein passing through it; at Hartford, in Connecticut, variegated sandstone has been altered to the extent of five feet under a covering of dolerite; the change of the brown coal at the Meissner extends, on an average, to eight feet under the basalt; that of chalk, in Ireland, to ten feet. The thickness of metamorphic coal sandstone, produced by a trap-dike in Ireland, extends even as far as forty feet; that of the metamorphic clay-slate, in Anglesea, extends to fifty feet; that of the metamorphic or altered coal at Blythe, in Northumberland, to ninety feet. Granite, syenite, and analogous rocks, appear to have exercised a much more widely-extended influence, whether it be that a longer-continued calorific radiation took place through these, as also their crystalline condition indicates, or that their effect on the adjoining rock has been altogether different from that of fiery molten masses. The metamorphosis of the limestone and of the clay-slate, near Christiania, extends to upwards of 1000 feet from the granite,—according to Durocher, even as far as 1000 yards or metres; that of the limestone of the Pyrenees, in S. Paul de Fenonillet, to at least 900 feet; the thickness of the white marble of Predazzo, on Pallerabbiose, and on Monzoni, or the gallestro slate and red jasper in Tuscany and in Elba, will be scarcely less; the influence of granite upon the clay-slate of Brittany extends, according to Durocher, to the distance of from two to three killometres.*

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* A killometer is equal to 1093⅔ yards.

Metamorphosis of Rocks by Vapours.

The experiments of Jeffreys shew that watery vapours produce no perceptible effect upon siliceous combinations, until the heat exceeds the melting point of cast-iron, but then quickly decompose felspathic rocks and other silicates, and line the roof of the furnace with a covering of siliceous earth resembling hoar-frost. The presence of siliceous earth in hot-springs is explained by this in a simple way.* The long-continued influence of heat at low temperatures is perhaps able, as frequently occurs in chemical reactions, to produce the ame result as higher temperatures. The decomposition which the jasper and hornstone, at M. Rotondo, adjacent to the Suffioni in Tuscany, suffer from its watery vapours, is in the highest degree remarkable; the red and dark-grey colours pass through different stripes into white; the compact texture is loosened, the stone becomes porous and pumice-like, and crumbles at last into a mealy powder. Inodorous aqueous vapour exercises the same decomposing influence on the trachyte of Terceira: the stone is changed into white, fine, earthy clay, whilst the iron carried off by the vapours accumulates in other places, and imparts a bright-red colour to the earthy mass; siliceous earth also is extracted, and again deposited as hyalite (Darwin). "The Telega-Leri in Java," says Junghuhn, "is a morass completely perforated by vapours; all the rocks are decomposed and metamorphosed into light-grey clay, only a few rocks shew still some cohesion, but these are also bleached. The water in the lake is milk-white, and in the middle is about thirty feet deep, and cold. On the banks we see hundreds of springs, of which the temperature in some is 57° C., and that in others 68° C. We cannot proceed a single step without coming upon hissing vapours or hot-jets, and we are continually enveloped in clouds of vapour, which, however, do not impede the respiration, and have only a very slight smell of sulphur." Not unfrequently the decomposing power of watery vapour is aided by an admixture of sulphurous or sulphuric acid. In the neighbourhood of the Stufe di S. Calogero in Lipari, according to Hoffmann, a fume-

* Studer's Geologie, vol. i., 247.

role of watery vapours, impregnated with sulphur, particularly attracts the attention, by the strikingly altered colouring of the soil: the face of a bold projecting felspathic lava is changed into a white, coarse-grained, chalky marl or tripoli-like rock; the adjacent tuffa, which is yellowish-white, very friable, and frequently intersected by dark-red streaks, incloses coarse lumps of a bluish-white stone, resembling opal or pitch-stone, the numerous crevices of which are lined with chalcedony or hyalite.

[We may add, as in some degree connected with the preceding, that the formation of many minerals by sublimation in smelting processes, and in active volcanoes and solfateros, is well known. Thus the rents in the walls of smelting furnaces are frequently filled or encrusted with metallic substances which could only reach these rents by sublimation. Crystals of lead-glance, and zinc-blende occur, on the walls and in the rents of furnaces where lead and zinc ores are smelted; and beautiful cubes of titanium are found in the walls of furnaces where titaniferous iron-ore is smelted. Graphite occurs in the vesicular cavities, or on the surface of iron slags, and appears in such to be a sublimation of carbonaceous matter. In nature we find graphite associated with minerals which many consider as formed at high temperatures, such as felspar, quartz, and mica; also in metamorphic marble and trap. Thus the famous graphite of Borrodale in Cumberland occurs in irregular nests in vertical veins in trap. The vein stones are calc-spar, brown-spar, and quartz.]

Metamorphosis of Rocks by Injection.

As on a grand scale, veins of fiery molten substances have filled up the interstices of sedimentary rocks, so in several cases narrow veins of molten substances appear to have penetrated into the rocky mass in such quantities, and so universally, that the rock acquires a wholly altered character, since the newly injected substance established itself as an essential ingredient of the rock. In the case of many quartzites in the flysch regions of Wallis and Grandbündten, this origin becomes not at all unlikely, when we see the veins of quartz, in the flysch, becoming more and more numerous, until, at last, only a few remaining thin slaty plates of flysch indicate the nature of the original rock. Quartz nodules also, as we frequently find them in clay-slate and mica-slate, may have arisen if the injected fluid was made to separate in consequence of the resistance of the mass penetrated. Masses of gneiss, which are penetrated by veins of granite or of porphry, have often the appearance of having been formed by the forcible entrance of felspath and quartz between the layers of the original slate. Through the influence of the high temperature of the injected mass, the slaty substance may at the same time have received a higher crystalline character, and have been developed as mica. East from Stockholm lies the quarry of Ytterby, so well known to all mineralogists, where, according to Von Buch, we have good illustrations of metamorphosis by injection. Possibly this explanation of metamorphosis and injection may also be applied to the gneiss of the Outer Hebrides, where, by the ramification of the many granitic veins, the original mass is, in some instances, almost supplanted. Molten metallic substances also may have mixed, by injection, with the adjoining rock; and Fournet is inclined to attribute to this cause not only the origin of the reticulated ramified ores in many mines, but also that of great masses, or of kidneys of ore, isolated on every side; the nearly mined-out nodules of pyrites of copper at Chessy, near Lyons, of manganese-ore near S. Marcel, in the valley of Aosta, of fahl-ore in Anniviers, and of white-lead in the Maurienne have, according to his view, originated through injection.

General Metamorphic Processes.

The difficulties which at present stand in the way of an explanation of those metamorphoses which occur most frequently, and in the greatest masses, are of different kinds. In several cases, the idea of a transformation appears contradictory to our chemical and physical laws, such as formerly was the case with the metamorphosis of carbonate of lime into marble by fusion, with the sublimation of silica, of oxide of iron, and of charcoal, and with the formation of felspath, and other minerals in the dry way. The explanation of still existing, seemingly contradictory facts must be looked for from the progress of science. In other cases, the metamorphosis extends to masses, the thickness of which far exceeds the limits of the observed influence of molten substances on the rocks adjacent to them, whilst mountains, many thousand feet thick, have been influenced by it. Besides, it frequently happens that we discover no eruptive rock to which we might ascribe the metamorphic influence. In many parts of the Alps, for instance, we may perceive the influence of the crystalline slate rock on the adjacent limestone. The latter, for several fathoms upwards, is bright or variegated crystalline, or changed into siliceous limestone or dolomite (Urbachvale, Grindelwald, Morcles, Oisans); but if the crystalline slates are themselves also of metamorphic origin, then we look in vain for a focus from which their metamorphoses can have proceeded. The greatest difficulty, however, lies in the fact, that metamorphic rocks are frequently separated by a series of extensive strata of unchanged rocks from every eruptive mass, as well as from the high temperatures of the interior of the earth ; sometimes they form the outermost covering of unchanged mountains, and are also frequently found alternated with strata, to which the metamorphic influence has not extended. An explanation of the metamorphosis, by the heat of the adjoining rocks, or by vapours, is evidently, in this case, insufficient. But that the cause of this metamorphosis, whichever it may be, is more closely connected with the processes of the interior of our globe, seems evident, from this circumstance, that these metamorphic rocks occur in those regions only which, by the up-raising of the originally horizontal series of strata, thus forming high mountains, or by the breaking out of eruptive rocks, bear unmistakeable traces of a former very intense influence of forces acting from the interior of the earth.

Massive Rocks.

The close connection of the greater number of metamorphic rocks with massive rocks, the perfect similarity of their mineralogical character, and the gradual transition of the one kind of rock into the other, lead to the conclusion that the massive rocks themselves are to be considered as merely the last stage of the conversion or change ; that granites also, and porphyries and trap-rocks have proceeded in a similar way from the original neptunian rocks, as undoubtedly is the case with massive limestone, dolomite, and quartzite. From this it also appears that the metamorphosis has, in individual cases, proceeded as far as fluidity, which is so evident in the case of granite or trap veins or dikes. In this point of view, all massive rocks form a series, which begins with marble and dolomite, and ends with the lavas of modern date. Of the trachytic rocks, granites and syenites are most closely allied to the metamorphic slates; the felspar porphyries form a middle link between the granites and the prismatic trachytes, which had formerly been in a state of fluidity. Amongst the trap-rocks, the diallage-traps which occur in rare instances only as eruptive veins, and never with a prismatic character, come nearest to the neptunian rocks; after these diallage-traps come the hornblende-traps, the metamorphosis of which takes place quite as frequently in a solid as in a fluid condition: last of all come the augitic-traps, to which class belongs basalt, almost identical with augitic lava. In several important cases, it is difficult to determine to what degree the metamorphosis has extended, since it remains uncertain whether the form and structural relations of the mountain-mass are to be considered as remains of the neptunian sedimentary formation, or as a product of the metamorphosis itself; for the original form of the neptunian, as well as of the volcanic sedimentary rocks have often become so changed by erosion, and so much alike in both classes of rocks, that this distinctive character is wholly lost; the slaty or tabular structure of lava-formed rocks becomes so entirely like the stratification of neptunian formations, that we are frequently puzzled regarding the explanation of this character.*

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* One of the earliest writers on mineral metamorphism was the celebrated Captain-General of the Saxon Mines, Charpentier; but the world is indebted to a remarkable man—the author of the famous Theory of the Earth, Dr Hutton of Edinburgh, for the first broad view of this subject in his work on the Theory of the Earth. Sir James Hall and Professors Playfair and Hope supported and extended this doctrine; Hall, by his celebrated experiments; Playfair, in his eloquent and classical "Illustrations of the Huttonian Theory;" and Dr Hope, by his admirable lectures on the subject in the class of Chemistry in our University. It may be said of Hope that the most brilliant part of his academical lectures was that on the Huttonian Theory. The celebrated Dr Boue, our excellent friend and former pupil, first made known, in detail, to Continental Geologists, the views of Hutton on this subject; about the same time, Thomson of Naples illustrated the metamorphism of rocks founded on his observations made in Italy; and more lately Keilhau and Scherer of Christiania, Von Buch, Bischof of Bonn, Studer of Bern, and Haidinger and Morlot of Vienna, have eminently contributed to this department of the geology of rocks. *Note by the Editor, Edin. New Phil. Jour.*

Tabular View of an Arrangement of Minerals, founded on Physical and Chemical Characters. By R. J.

CLASS I. *M.*

ACROGENOUS MINERALS (*Haidinger.*)

Minerals that occur chiefly on the surface of the Earth or soil.

Characters of the Class.—If solid, is sapid. Specific gravity less than 3·8.

ORDER 1.—GAS. *Genera.* 1.—Hydrogen Gas, &c.
ORDER 2.—WATER. *Genera.* 1.—Sea Water, &c.
ORDER 3.—ACIDS. *Genera.* 1.—Boracic Acid, &c.
ORDER 4.—SALT. *Genera.* 1.—Natron, or Carbonate of Soda, &c.

CLASS II. *M.*

GEOGENOUS MINERALS. *H.*

Minerals of which the known solid part of the Earth is chiefly composed.

Characters of the Class.—Specific gravity more than 1·8. Tasteless.

SUBCLASS I.—HALOIDAL MINERALS.

Tasteless compounds of Earths and Acids, and Tasteless compounds of Metals and Acids.

ORDER 1.—HALLITE. Tasteless compounds of Earths and Acids.

* *Kuphallite. Light, Tasteless, Saline Minerals.*

Genera. 1. Gypsum. 2. Anhydrite. 3. Calc-Spar. 4. Fluor. 5. Apatite. 6. Alumstone. 7. Wavellite. 8. Cryolite.

** *Barallite. Heavy, Tasteless, Saline Minerals.*

Genera. 1. Heavy-Spar, including Barytic Spars, and Strontianitic Spars.

Subclass II.—HALOCHALCITE.

Saline Ores, or Tasteless compounds of Metals and Acids.

Order I. BARALOCHALCITE.—*Heavy, Tasteless, Saline Ores.*

Not metallic. No metallic pearly lustre. Streak white, pale-brown, orange-yellow. Hardness = 2·0—5·5. Specific gravity = 3·3—8·1.

Genera. 1. Sparry-Iron. 2. Red Manganese. 3. Retine-Spar. 4. Tungsten. 5. Calamine. 6. Lead-Spar. 7. White Antimony; or Antimony-Spar.

Order II. KUPHALOCHALCITE.—*Light, Tasteless, Saline Ores.*

Not metallic. Colour blue, green, yellow. Streak blue, green, brown. Hardness = 2·0—5·0. Sp. gr. = 2·5—4·2.

Genera. 1. Liriconite. 2. Olivenite. 3. Blue Malachite. 4. Emerald Malachite, or Silicate of Copper. 5. Green Malachite. 6. Dystom-Malachite. 7. Copper-Green.

Order III. MICALOCHALCITE.—*Tasteless, Micaceous, Saline Ores;* or, *Mica-like Saline Ores.*

Genera. 1. Copper-Mica. 2. Uran-Mica.

Order IV. KERALOCHALCITE.—*Corneous, Tasteless, Saline Ores.*

Not metallic. Streak white or grey. No single distinct cleavage. Hardness = 1·0—2·0. Sp. gr. = 5·5—6·5.

Genera. Horn-Ore.

Subclass III.—TERRIGENOUS OR EARTHY MINERALS.

Minerals in most cases composed of one earth or more frequently coloured by Metallic Oxides, especially Oxide of Iron.

Order I. STEATITE.

Not metallic. Streak white. Hardness = 1·5—4·0. Sp. gr. = 2·47—3·0.

Genera. 1. Picrosmine. 2. Serpentine. 3. Glyphine-Steatite or Common Steatite. 3. Praseolite. 4. Pyrargillite. 5. Agalmatolite. 6. Gieseckite. 7. Plinthite. 8. Pinite. 9. Gigantolite. 10. Gilbertite. 11. Gibbsite. 12. Osmelite.

Order II. MICA.

Not metallic. Cleavage distinctly axotomous. Streak white···green. Hardness = 1·0—4·5. Sp. gr. = 2·3—3·4.

Genera. * 1 Hydrargillite. 2. Brucite or Pearl-Mica. 3. Nemalite. 4. Volknerite.
** 5. Talc. 6. Nacrite. 7. Pyrophyllite. 8. Chlorite. 9. Mica. 10. Biotite.

Order III. SPAR.

Not metallic. Streak white, reddish-brown, blue. Hardness = 2·5—7·0. Sp. gr. = 2·0—3·7.

Genera. 1. Schillerite. 2. Kyanite. 3. Diaspore. 4. Triphane. 5. Prehnite. 6. Datolite. 7. Wagnerite. 8. Amphigene. 9. Zeolite. 10. Edingtonite. 11. Elaine-Spar. 12. Petalite. 13. Felspar. 14. Chiastolite. 15. Augite.. 16. Almandine-Spar or Eudyalite-Spar. 17. Azure-Spar. 18. Adiaphane Spar.

Order IV. GEM.

Not metallic. No metallic adamantine lustre. Streak white. Hardness = 5·5—10·0. Sp. gr. = 1·9—4·7.

Genera. 1. Andalusite. 2. Corundum. 3. Diamond. 4. Topaz. 5. Emerald. 6. Quartz. 7. Axinite. 8. Chrysolite. 9. Boracite. 10. Tourmaline. 11. Garnet. 12. Zircon.

Subclass IV.—METALLIFEROUS MINERALS.

Minerals in which Metals, generally the chief constituents, are in the native state, or combined with Oxygen or Sulphur.

Order I. ORE or OXIDE.

Metallic, black, not metallic. Streak not green, not blue. Hardness = 2·0—7·0. Sp. gr. = 3·4—8·0.

Genera. 1. Titanium-Ore. 2. Zinc-Ore or Red Oxide of Zinc. 3. Red Copper Ore or Red Oxide of Copper. 4. Tin-Ore or Oxide of Tin. 5. Tantalum-Ore. 6. Wolfram-Ore. 7. Uranium-Ore. 8. Cerium-Ore. 9. Chrome-Ore. 10. Iron-Ore. 11. Melane-Ore. 12. Manganese-Ore.

Order II. METALS, or NATIVE METALS.

Metallic. Not lead-grey, not black. Fluid, solid. Hardness = 0·0—7·0. Sp. gr. = 5·7—21·0.

Genera. 1. Arsenic. 2. Tellurium. 3. Antimony. 4. Bismuth. 5. Mercury. 6. Silver. 7. Gold. 8. Iridium. 9. Palladium. 10. Platina. 11. Iron. 12. Copper.

Order III. PYRITES, or HARD SULPHURETS.

Metallic. Not lead-grey, not black. Streak black. Hardness = 3·0—6·5. Sp. gr. = 4·2—7·7.

Genera. 1. Nickel-Pyrites, or Copper-Nickel, or Arsenical Nickel. 2. Arsenical-Pyrite. 3. Cobalt-Pyrites. Iron-Pyrites. Copper-Pyrites.

Order IV. GLANCE, or SEMIHARD SULPHURETS.

Metallic. Colour grey, black, brown. Hardness = 1·0—4·0. Sp. gr. = 4·2—8·8.

Genera. 1. Dystom-Glance. 2. Copper-Glance. 3. Silver-Glance. 4. Lead-Glance. 5. Eutomous Glance. 6. Bismuth-Glance. 6. Antimony-Glance. 8. Melane-Glance.

Order V. BLENDE, or SULPHURETS WITHOUT METALLIC LUSTRE.

Metallic, black; not metallic. Streak green, red, orange, brown, white. Hardness = 1·0—5·0. Sp. gr. = 2·8—8·2.

Genera. 1. Manganese-Blende. 2. Bismuth-Blende. 3. Cadmium-Blende (Greenockite, *Jam.*) 4. Zinc-Blende or Garnet-Blende. 5. Antimony-Blende, or Purple-Blende. 6. Ruby-Blende.

Order VI. THIOLITE.

Not metallic. Colour, red, yellow, brown. Streak red, yellow, white. Hardness = 1·5—2·5. Sp. gr. 1·9 = 3·6.

Genera. 1. Orpiment (Auripigment or Rauschgelb). 2. Realgar or Rauschroth. 3. Sulphur.

CLASS III. *M.*

Phytogenous Minerals. *H.*

Minerals chiefly formed of mineralized vegetable matters.

Characters of the Class.—Specific gravity less than 1·8. If liquid, the smell is bituminous. If solid, is tasteless.

Order I. RESIN.

Fluid and Solid. Hardness = 0·0—2·5. Sp. gr. = 0·8 = 1·6. If sp. gr. = 1·2, and more, the streak is white and grey.

Genera. Mellite, or Honeystone. 2. Mineral Resin.

Order II. COAL.

Solid. Streak brown, black. Hardness = 1·0—2·5. Sp. gr. = 1·2—2·2.

If the specific gravity = 1·4 and more, the streak is black, and without considerable lustre.

Genera. 1. Black Coal. 2. Brown Coal. 3. Anthracite. 4. Graphite ?

Notice of Plants which have Flowered recently in the Royal Botanic Garden, and other Gardens near Edinburgh. By J. H. Balfour, M.D., F.L.S., Professor of Botany in the University of Edinburgh. Communicated by the Author.

Livistona chinensis, *Martius.*—Nat. Ord. Palmæ. Tribe Coryphinæ, *Mart.*—Hexandria Monogynia.

Generic Character.—*Flores* hermaphroditi in spadice spathis pluribus incompletis basilaribus cincto sessiles, bracteati. *Calyx* trifidus. *Corolla* tripartita. *Stamina* sex; *filamenta* in discum hypogynum coalita; *antheræ* caudato-oblongæ. *Ovarii* carpidia tria, intus cohærentia; *styli* coalescentes; *stigmatibus* connatis vel distinctis. *Bacca* plerumque unica, monosperma. *Albumen* cavitate ventrali testæ radio horizontali ruminatum. *Embryo* dorsalis.—Palmæ *in Nova Hollandia et in Asia tropica observatæ*; caudice *mediocri, frondium basibus persistentibus squamato,* frondibus *flabelliformibus, laciniis apice bifidis sæpe pilis interjectis, distinctis. Endlicher.*

The genus was named by Brown (Fl. Nov. Holl., p. 267) in honour of Patrick Murray, Baron of Livistone, who had a botanic garden on his estate in which more than 1000 plants were cultivated, and which he handed over to the Edinburgh Botanic Garden at its first foundation, towards the end of the seventeenth century.*

Specific Character.—Caudice mediocri, petiolis laminæ diametrum subæquantibus a basi ad medium usque aculeatis, laminæ laciniis longe bifidis interdum filis interjectis, baccis olivæformibus, ellipticis olivaceo-viridibus.

Latania chinensis, *Jacq.* Fragm. Bot., p. 16, t. 11, f. 1.

Latania borbonica, *Lam.* Encyclop. III., p. 411. *Willd.* Spec. Plant. IV., p. 878. *Spreng.* Syst. Veg. II., p. 623.

Livistona chinensis, *Mart.* Palm., 146.

Livistona Mauritiana of Wallich, according to Martius.

This palm is a native of Southern China. It is cultivated under the name of "Latanier de la Chine" in the Mauritius, whence it was introduced into the Garden at Schoenbrunn. It grows also in the Calcutta Garden.

The plant in the Palmhouse of the Botanic Garden has attained the height of 25 feet, the stem at the lower part having a diameter of 22 inches. The *caudex* or *stipe* is covered with the persistent bases of the leaves and their reticulum, except at the

* Memoria Balfouriana, p. 69, *et seq.*

lower portion, where the surface presents a wrinkled and spongy aspect. *Fronds* numerous, forming a large hemispherical coma, some of them spreading, others nearly erect; their base surrounded with a brown fibrous reticulum or mattulla, consisting of a coriaceous membrane and interlacing fibres, which arise laterally from the base of the petiole. *Petioles* about 8 feet long, flat above or slightly concave towards the margin, convex and keeled below, becoming broad at their base where they join the stem, and giving off a fibrous membrane at their sides; compressed where they join the lamina, and forming there a projecting pointed sort of ligule on their upper surface. Margin of the petioles acute, covered to about $\frac{1}{3}$ or $\frac{1}{2}$ its length from the base with straight compressed subulate horny roughish spines, pointing downwards, varying from 3 lines to 1 inch in length, and placed at the distance of $\frac{1}{2}$ to $\frac{3}{4}$ of an inch from each other. *Lamina* or *blade* of frond, suborbicular, flabelliform or fan-shaped, its extreme breadth 7 feet, with from 80 to 90 rays; laciniæ linear-lanceolate, acuminate, united by commissural ribs; length of laciniæ varying from 2 feet to 5 feet, their apices bifid, and the segments acute, brownish, 6 inches long. *Flowers* on axillary spadices, three of which have been produced by the plant. Whole *Inflorescence* from 4 to $4\frac{1}{2}$ feet long, spreading in the form of a branching panicle.

General Rachis or peduncle flexuous, somewhat flattened at the base, where it is between 1 and 2 inches in diameter, giving origin to primary branches (about 1 inch in diameter at their base), which are alternate, and divide into numerous secondary and tertiary peduncles. All the peduncles are alternate and tapering, and the ultimate divisions bear about 40 flowers. On an entire spadix about 10,000 flowers were counted. The spadix, when fresh, gives out an odour like cauliflower, and when a section is made it becomes speedily brown by exposure to the air. On examination under the microscope, the spadix presents spiral and annular vessels, along with fusiform woody tubes. *Basilar sheaths* or *spathes* two, about 20 inches long, green at their lower part, brown above, bifid at the apex, the segments being triangular, acute, of a coriaceous woody texture, furrowed in the middle and keeled towards the margin on the upper side, smooth in the inside, and covered on the outside with greyish tomentum and scales, which consist of elongated cells placed end to end. *Partial spathes* three, giving off from their axil three primary branches, to which they are united at the base, about 1 foot long, green at their lower part, brown at the apex, lanceolate, flattish, hollowed in the part next the rachis, keeled near the margin, slightly swollen below the cleft whence the peduncles proceed, covered, like the basilar spathes, but more sparingly, with tomentum and scales. Triangular, subulate, membranaceous, brownish *bracts* occur in various parts of the inflorescence, especially at the points where the primary and secondary peduncles come off; they are sometimes very acute, and vary in length from half an inch to 4 inches.

Flowers hermaphrodite, small, yellowish, sessile, occasionally placed singly on the rachis, but generally in clusters of 3, the central flower opening first. Clusters placed alternately in a spiral order. *Perianth* or *perigone* double. Outer perianth or *calyx* 3-cleft, segments broadly ovato-triangular, tip often brownish, closely applied to the inner perianth, and about half its length. Inner perianth or *corolla* 3-partite, segments ovate, concave internally, united at the base, æstivation valvate. *Stamens* 6, included; filaments dilating downwards in a triangular form, and ending in a disk-like membrane which unites their bases, and is hypogynous; anthers ovate, bifid at the base, versatile, introrse, with longitudinal dehiscence; pollen yellow, elliptical, furrowed. *Pistil* small, consisting of 3 carpels united; ovary rounded, flattened above, obsoletely 3-lobed; ovule erect, one in each cell; style short, subulate, trigonous; stigma depressed, capitate. Fruit an olive-like berry, usually single, containing only one seed, in consequence of the abortion of two ovules; albumen cartilaginous; embryo cylindrical.

This plant was introduced into the Edinburgh Botanic Garden about 30 years ago from Kew. It is now about 36 years old. It produced flowers in February 1847. This seems to be the first time that it has flowered in Britain, and perhaps in Europe. Mr N. B., Ward informs me, that it has not flowered in Messrs Loddiges' palm-house. He says, " The plant at Hackney is most gigantic, but the roots have made their way through the bottom of the tub, and are now growing in the soil, which may possibly account for its not having flowered."

PRIMULA STUARTII, *Wall.*—Nat. Ord. Primulaceæ.—Pentandria Monogynia.

GENERIC CHARACTER.—*Calyx* subcampanulatus vel tubulosus, sæpius angulatus vel inflatus, quinquedentatus vel quinquefidus. *Corolla* hypogyna, infundibuliformis vel hypocraterimorpha, tubo cylindraceo, brevi vel elongato, ad faucem dilatato, limbo quinquefido, laciniis obtusis, emarginatis vel bifidis. *Stamina* quinque, corolla tubo inserta, ejusdem laciniis opposita, inclusa; *filamenta* brevissima; antheræ oblongæ, biloculares, longitudinaliter dehiscentes. *Ovarium* globosum, uniloculare, placenta basilari substipitata. *Ovula* plurima, punctato-rugosa, peltatim amphitropa, dorso plana, ventre convexa. *Capsula* ovata quinquevalvis, valvulis integris aut bifidis apice tantum dehiscentibus. *Semina* minima, numerosa.

Embryo in axi albuminis carnosi.—Herbæ *in Europa et Asia imprimis alpicolæ, in America boreali raræ,* foliis *plerumque radicalibus, scapo simplici,* floribus *umbellatis, involucratis, sæpissime speciosis. Endlicher* et *Duby.*

Specific Character.—Foliis lævibus, planis, late lanceolatis, acutis, glaberrimis, subtis farinâ luteâ obtectis, acute serratis, interdum margine revolutis, in petiolum late alatum basi dilatatum membranaceum subvaginantem subcoarctatis; scapo crasso, glabro, foliis longiore, sub involucro farinoso, involucri multiflori polyphylli pedicellos subæquantibus et illis interdum brevioris foliolis inæqualibus e basi anguste lanceolata acuminato-elongatis obtusiusculis, calycis farinacei campanulato-tubulosi subultra-quinquefidi tubo dimidio brevioris laciniis lanceolatis subacutis, corollæ hypocraterimorphæ lobis obrotundis subcrenulatis vix emarginatis. *Duby.*

Primula Stuartii, *Wall.* Fl. Ind., ii., p. 20. *Duby* in Dec. Prod., viii., p. 41. *Don,* Prodrom. Flor. Nepal., p. 80. *Balfour* in Botanical Magazine, 4356.

This beautiful perennial herbaceous Primrose is a native of the mountainous parts of India, having been gathered in Gossain-Than in Nepal, by Wallich, and on the Himalayah, at an elevation of 9000 feet, by Royle, who speaks of it as giving a rich yellow glow to those regions. The plant flowered in the garden of the Edinburgh Horticultural Society, under the superintendence of Mr James M'Nab, during the summer of 1847, having been presented by the late Sheriff Speirs, in whose garden, at Granton House, it was raised from seeds sent from India by Major Grant, 9th Lancers, during the spring of 1845. It was planted in a north exposed border in the summer of 1846, in a mixture of loam and peat. It stood the winter of 1846–47 unprotected, and without any artificial covering except its own decayed leaves. The plant did not produce seed.

Plant about 16 inches high. *Leaves* 10 or 11 inches long, numerous, radical, erect, smooth, broadly lanceolate, acute, shining above, covered below with a yellowish mealy matter or farina (the grains of which are supported on short cellular projections), gradually ending in a sheathing petiole, which is deeply hollowed in its upper surface; margins of leaves slightly undulated with close sharp serratures, which are occasionally directed downwards, and are somewhat revolute at the point; midrib very prominent on the lower side, grooved in the upper, not covered with mealiness. *Vernation* revolute. *Scape* umbellate with numerous flowers longer than the leaves, covered for about half its length from below the point where the pedicels diverge with a pale sulphur-yellow farina, similar to that on the leaves. *Involucre* polyphyllous, leaflets (one of which is at the base of each pedicel) lanceolate, from ½ to ¾ quarters of an inch long, and shorter than the pedicels, which are from 1 inch to 1¼ inch in length. *Calyx* gamosepalous, 5-cleft, campanulato-tubular, covered with farina, its segments lanceolate-acute. *Corolla* yellow, gamopetalous, salver-shaped, its tube twice as long as the calyx, narrow about the middle, and expanding in a somewhat campanulate manner towards its union with the limb, where there is a marked constriction ; limb of an orange tint towards the centre of the flower, with five grooves at the part where it joins the tube, having five segments, which are rounded, waved, somewhat crenate, covered with minute capitate hairs. *Stamens* five, attached to the corolla, free part of filaments very short, anthers opening longitudinally, introrse; *pollen* spherical. *Ovary* rounded, oblong, having an appearance of 10 teeth at its apex, indicating five bidentate carpels; *style* round; *stigma* capitate, obscurely 5-lobed, with a depression in the centre; *placenta* free, central, with numerous rows of amphitropal ovules.

Localities for Rare Highland Plants.

The following observations were made during an excursion to the Braemar, Clova, and Breadalbane districts in August 1847, a fuller notice of which will appear in the next Number of the Journal.

1. *Carex leporina*, L., was picked near the summit of Cairn Toul, between 3000 and 4000 feet above the level of the sea. This is the second British locality for the plant. It was also gathered in Dr Dickie's original locality on Lochnagar.
2. *Sonchus alpinus*, L. (*Mulgedium alpinum, Less.*), was found by Mr W. Douglas in profusion on Lochnagar, a locality in which it has not been noticed since the days of Don. It grows on cliffs, which are not easily accessible, and hence it has been passed over by botanists. This re-discovery of one of Don's stations confirms the opinion, that ultimately those plants which have not been found since his day, such as *Potentilla tridentata Ranunculus alpestris*, &c., will yet reward the investigations of botanists.
3. *Carex vaginata, Tausch.*, was found abundantly on every mountain in the Braemar and Clova district. It is particularly plentiful on Ben-Aven and Ben-na-Muich Dhui.
4. *Luzula arcuata, Hook.*, is also generally diffused on the mountains of that district, having been found on Lochnagar, Ben-Aven, Ben-na-Muich Dhui, Breriach, and Cairn Toul.
5. *Hieracium villosum? Sm.*, on Lochnagar. This is perhaps *H. alpinum, var., longifolium of the Flor. Siles.*
6. *Woodsia hyperborea, Br.*, was pulled in Glen Isla, Glen Phee, and on Ben Lawers.
7. *Equisetum umbrosum, Willd.*, occurred on the hills near Ballater.
8. *Orobus niger, L.*, was found in profusion in the woods at the Pass of Killiecrankie.

Abstract of Meteorological Observations for 1847, *made at Applegarth, Dumfriesshire.* By Rev. Wm. Dunbar, D.D.

Long. 3° 12′ W., Lat. 55° 13′ N. Height above the Sea, 180 feet; Distance from the Sea, 10 miles. Rain-Gauge 5 feet from the Ground.
The Observations made at 9 A.M. and 9 P.M.

BAROMETER.

1847. Months.	Atmospheric Pressure, Morning.	Atmospheric Pressure, Evening.	Mean of Morning and Evening.	Reduced to 32° Fahr., and corrected to sea-level.	Mean Daily Range.	Mean Nightly Range.	Mean Range in 24 hours.	Monthly Extremes. Highest.	Lowest.	Greatest Range in 24 hours.	Least Range in 24 hours.
January	29·69	29·65	29·67	29·83	0·082	0·085	0·167	30·28	28·72	0·37	0·03
February	29·72	29·73	29·72	29·88	0·085	0·091	0·176	30·28	29·18	0·50	0·03
March	29·86	29·83	29·85	29·98	0·090	0·073	0·163	30·51	29·17	0·50	0·02
April	29·59	29·60	29·60	29·73	0·080	0·098	0·178	30·03	29·10	0·50	0·02
May	29·70	29·73	29·71	29·81	0·083	0·083	0·166	30·41	29·35	0·42	0·01
June	29·83	29·81	29·82	29·91	0·092	0·057	0·149	30·42	29·25	0·40	0·01
July	29·95	29·94	29·94	30·01	0·053	0·038	0·091	30·29	29·65	0·41	0·02
August	29·88	29·88	29·88	29·98	0·088	0·099	0·187	30·32	29·25	0·63	0·02
September	29·74	29·74	29·74	29·85	0·111	0·104	0·215	30·27	28·87	0·81	0·01
October	29·76	29·75	29·75	29·87	0·117	0·092	0·209	30·19	29·17	0·52	0·01
November	29·72	29·71	29·71	29·84	0·141	0·135	0·276	30·30	28·90	0·62	0·08
December	29·57	29·57	29·57	29·71	0·141	0·180	0·321	30·22	28·19	0·82	0·03
Means	29·75	29·74	29·75	29·86	0·097	0·094	0·191				
1846	29·66	29·67	29·67	29·79	0·115	0·106	0·221				

THERMOMETER.

Months.	Mean of Greatest Heat.	Mean of Greatest Cold.	Mean Temp. of Morning.	Mean Temp. of Evening.	Mean of Extremes.	Mean of Morning and Evening.	Mean of Both.	Mean Range in 24 hours.	Monthly Extremes. Highest.	Lowest.	Greatest Range in 24 hours.	Least Range in 24 hours.
January	40·0	32·1	35·4	36·4	36·0	35·9	35·9	8·2	47·0	19·5	23·5	2·0
February	42·7	31·1	35·0	36·3	36·9	35·6	36·2	10·7	51·0	19·5	19·5	6·0
March	49·7	36·8	41·6	42·0	43·2	41·8	42·5	12·9	61·0	21·5	22·0	6·0
April	52·0	35·7	43·7	42·6	43·8	43·1	43·4	16·3	60·0	26·0	28·0	7·0
May	57·5	44·8	52·2	50·0	51·5	51·1	51·1	12·4	72·5	39·0	25·0	2·0
June	62·0	48·0	56·2	54·7	55·0	55·4	55·2	13·7	74·0	37·0	24·0	5·0
July	69·3	53·8	61·6	61·5	61·5	61·5	61·5	15·6	78·5	44·0	30·0	6·0
August	64·3	50·1	57·8	56·4	57·2	57·1	57·1	15·9	71·0	37·5	27·5	5·0
September	58·2	44·0	51·6	49·9	51·1	50·7	50·9	14·1	62·0	33·0	25·5	6·5
October	54·7	45·0	49·7	49·0	49·8	49·3	49·5	9·7	67·0	36·0	18·5	2·5
November	50·5	41·4	44·6	46·4	45·9	45·5	45·7	9·1	58·0	26·5	20·0	2·0
December	44·4	33·5	40·0	40·0	40·4	40·0	40·2	7·9	54·0	11·5	19·0	0·5
Means	53·7	41·6	47·4	47·1	47·7	47·2	47·4	12·2				
1846	55·9	44·3	50·1	49·3	50·1	49·7	49·9	12·4				

Dr Dunbar's *Meteorological Observations for* 1847—(Continued).

WINDS—THEIR DIRECTION AND FORCE, AND WEATHER, IN THE NUMBER OF DAYS IN WHICH EACH PREVAILED.

Months.	N.	NE.	E.	SE.	S.	SW.	W.	NW.	Calm.	Moderate.	Brisk.	Strong Breeze. Boist.	Stormy.	Sun Shone out.	Rain fell.	Snow or Hail.	Frost.	Thunder.	Rain in Inches.
January	...	5	13½	6½	3	1	1	1	9	9	1	10	2	21	7	4	18	...	1·38
February	...	3	6	2	2½	2½	3½	6½	4	7	5	8	3	26	9	5	18	...	1·17
March	3	9	4	6	1	2	2	4	5	7	6	13	...	29	8	5	12	1	1·27
April	1½	4½	3	½	...	3½	14	3	10½	5	6	6½	2	27	12	5	7	1	1·32
May	...	2	3½	5	2½	8	10	...	14	11	2	4	...	27	18	...	...	2	2·50
June	...	2½	1	1½	1½	12	2½	9	9	9	9	3	...	29	17	Fog.	...	4	2·32
July	½	2	4	2	5	8½	4	5	19	2	7	3	...	31	7	2	...	7	1·03
August	½	2	1½	...	3	17	5	2	11	5	12	3	...	30	16	...	...	...	2·23
September	1	3	2	1	1	10	6	6	3	13	5	6	3	22	16	Fog.	1	...	1·22
October	...	10	4	2	3	8	3	1	9	9	7	6	...	23	18	1	...	...	5·09
November	2½	3	1	3	4	10	4½	2	10½	6½	4	8	1	20	18	...	6	...	3·79
December	1	6	3½	7	2	7½	3	1	4½	10	7½	7	2	22	14	4	11	...	4·18
Total	10	52	47	36½	28½	90	58½	40½	107½	93½	71½	77½	13	307	160	26 ·	73	15	27·50
1846	15	52½	37	48½	28	102	41½	40	130	99½	37½	91	8	293	187	16	53	19	37·16

REMARKS.

The maximum of *Atmospherical Pressure* was on the 3d of March, when the Mercury stood at 30°·51. The minimum on the 6th of December, 28°·19. Range, 2·32 inches.

The maximum *Temperature* was on the 5th of July, viz., 78°·5; in 1846 it was 83°·0. Minimum, 31st December, 11°·5; in 1846 it was 18°. The mean of extremes exceeds the mean of morning and evening by ½ degree. The mean temperature of the year is 47°·4, lower than that of 1846 by 2½ degrees, but higher than the annual mean for the last 25 years by 1 and one-tenth degree. The summer was most beautiful and genial.

The quantity of *Rain* is 10 inches less in this locality than in 1846; and 6¾ inches less than the annual mean for the last 20 years. Nearly the half of the whole fell in the three months of October, November, and December.

Frost prevailed on 73 days, one-fifth of the whole year, frequently, however, in a very slight degree, and chiefly in the first four months, during which it equalled the extent of the whole of 1846.

Snow fell on 23 days, but chiefly in the beginning of the year, though in this locality to never more than half an inch in depth; on the 29th of December it fell to the depth of about 3 inches, but lay only five days.

The *Winds* have, on the whole, been rather violent; the calm days considerable fewer than usual; but the clear brisk days double in numbers; and the stormy days nearly in the same proportion.

SCIENTIFIC INTELLIGENCE.

ANTHROPOLOGY.

1. *On a Universal Language.*—The idea of a universal language has long been a favourite with sanguine and speculative minds; each individual speculator looking to his native tongue for the common interpreter, and of course overrating its natural fitness for such an office. Sir John Herschel has said that the adoption of a common language—at least by the leading nations of the world—is one of the grand *desiderata* at which mankind should aim by general consent. On the other hand, there are ethnolgists who repudiate the notion altogether, looking upon the varieties of form and terminology in language as the natural result and expression of organic differences of race and climatic environment, and, therefore, on the diversity as an inevitable consequence of causes which no artificial arrangements can ever permanently overcome. The moral and intellectual advantages of unity of speech in neighbouring nations are manifest and momentous; and the argument, that the common medium of communication to be adopted should be the language of Shakespear, is based as follows:—Of the three great tongues of Europe, English, French, and Dutch, it possesses, in a higher degree than either of its rivals, nearly all those natural and accidental advantages which are necessary to qualify it for universality, namely — organic simplicity, acquired wealth, extent of present diffusion, and irrevocable connection with rapidly expanding institutions. In its easiness of grammatical construction—in its almost total disregard of the distinctions of gender, excepting those of nature—in the simplicity and precison of its terminations and auxiliary verbs, not less than in the majesty, vigour, and copiousness of its expression, our mother tongue seems well adapted by *organization* to become the language of the world. To boast of its wealth is needless, with such a literature as exists to prove it. It its now spoken by sixty millions of people: and before the termination of the present century, will, in all human probability, be spoken by two hundred millions, in the British Islands, in the United States, in Canada, in Central America, in Guiana, in the West Indian group of Islands, on the seaboard of Africa, in Hindostan, in the Asiatic Archipelago, and in Australia and the vast islands of the surrounding seas—a population nearly equal to that of the whole of Europe. To what extent the revolutions of science, the progress of free institutions, and the developments of civilization generally may contribute to spread the English language on the neighbouring Continent it is not so easy to determine; but it need scarcely be supposed that a language which has already belted the world, and established itself permanently in every latitude, will prove unable in the future, with new advantages in its favour, to fix itself firmly in the countries of Europe.

Assuming the argument, it follows that a language with such a destiny before it should be stripped as much as possible of all accidental excrescences and anomalies, and rendered as perfect an instrument as skill and judgment can make it. Its phonology is remarkably imperfect—its spelling is cumbersome and arbitrary beyond all reasonable limits,—and its irregularities of declension and conjugation are more numerous than they need be.—*Athenæum.*

2. *Caffers described.*—It is now pretty generally admitted that the Caffers belong to the Negro race of mankind; but the characteristic peculiarities of that race, with the exception of the woolly hair, are less strongly marked in them than in the natives of Guinea or Mozambique; the lips are less thick, the nose less flat, the lower part of the face is not remarkably prominent, and the forehead is often as high and as amply developed as in Europeans. The colour of the skin appeared to me, in most of the individuals I saw, to be a *dark umber brown*, frequently approaching to black, while in others it had a tinge of yellow or red; but the skin is so often smeared with red ochre, that it is not easy to judge accurately of its real native tint. The Caffer men are in general tall, though not gigantic, and extremely well proportioned: indeed their fine forms and easy attitudes often remind one of ancient statues; but they are more remarkable for activity than for strength; and it is said, have generally been found inferior in muscular power to British soldiers. —*Residence at the Cape of Good Hope, by Charles F. Bunbury.* p. 166

3. *Hottentots described.*—We had been escorted in our little tour into Cafferland by detachments of the Hottentot corps, or Cape Mounted Rifles, who are, or were at that time, the only cavalry in the colony, and seem well suited for the frontier service. The officers are English, the men partly of mixed breed, and partly genuine Hottentots. These latter people, of whom I saw a considerable number in Graham's Town and its neighbourhood, have a most peculiar and repulsive physiognomy. The form of the face is singularly angular, owing to the excessive projection of the cheekbones, the shrunk and pinched appearance of the lower part of the cheeks, and the sharpness of the chin; the mouth is prominent, and the lips thick; the eyes very small and narrow, and rather obliquely placed; the forehead depressed; the nose flattened in a remarkable degree, so that the upper part of it appears to be quite obliterated, while the nostrils are large and wide. The plates in Le Vaillant's Travels do not at all exaggerate the usual ugliness of this strange race; but whether his account of their moral qualities be correct, I cannot tell. I never saw any of them in their original state of wild independence; and if they ever were such as he describes them, they have become sadly deteriorated from their intercourse with civilized men. Many people are struck with the likeness of the Hottentots

to the Chinese in physiognomy; and Dr Prichard considers this approximation as confirmed by the formation of the skull; the woolly hair, in which they differ remarkably from the Mongolian nations, may be a character of secondary importance. The Hottentots are mostly of small stature; the majority of those in the Cape corps (at least of the new levies) are under five feet high, and they are possessed of very little muscular strength. Their hands and feet are small and delicate; in which particular they differ very remarkably from the Negroes.

The number of genuine Hottentots within the colony at the present day is small compared with that of the mixed breeds, or Bastaards, as they are called, in whom the blood of the aboriginal race is crossed with that of the Dutch, the Negro, or the Malay. The Bastaards are much superior in size and strength to the Hottentots. —*Charles F. Bunbury on the Cape of Good Hope*, p. 164.

4. *Fingoes described.*—The Fingoes are remnants of several tribes of the Caffer race, who had inhabited the country near Port Natal, but had been exterminated or driven into exile by Chaka, the terrible chief of the Zoolos. Of those whom we met here, some were under the middle size, others considerably above it, slenderly but actively made; their colour not quite black, but a very *dark umber-brown*, totally different from the dirty *yellowish-brown of the Hottentots*, to whom, indeed, they have no resemblance, except in the woolly hair. They were, however, considerably inferior in personal appearance to the Caffers whom we afterwards saw; the women, in particular, were far from prepossessing.—*Journal of a Residence at the Cape of Good Hope, by Charles F. Bunbury*, p. 116.

5. "*Ceaird*" *the Celtic Appellation for* "*Gypsies.*"—This term primarily signifies "trade, occupation, or any handicraft," by which gain is made, and may have in this respect some radical affinity to the Greek κεϱδος *gain*, which is also employed in a more extended sense to express "craftiness" or "subtlety." The word "Ceard" comes to be applicable, by a natural transition, from the *craft* to the *craftsman*; most commonly it is used for this purpose in apposition, as "*or-cheard*," goldsmith,—"*ceard-umha*," coppersmith. A good illustration of the mode of employing the term occurs in the Gaelic version of the Scriptures, with reference to the artificers of Ephesus, Acts xix. verses 24–25, who are described as craftsmen (luchd-*ceaird*), whose craft (ceard) as silversmiths (ceaird-airgid), consisted in making silver shrines for the goddess Diana.

In a more generic and distinctive sense, however, the term "ceaird" is employed in the Highland districts, without any qualifying adjunct or limitation, to all itinerant tinsmiths, horn-spoon manufacturers, and pre-eminently to the "gypsy" tribes. Of the latter, "Ceaird" is the peculiar appellative, without any ambiguity of meaning, generally pronounced like the last syllable of the verb dis*card*, and always conveys the same idea of opprobrium which attaches to the English word "tinker," and for this reason holds a prominent place among the abusive epithets interchanged in colloquial altercations.—*Charles M. MacRae.*

ZOOLOGY.

6. *On the Skulls of adult and aged Male and Female Chimpanzees.* —*Zoological Society*, Feb. 22.—*W. Yarrell, V.-P. in the Chair.* Professor Owen read a paper on the skulls of adult and aged male and female Chimpanzees from the Gaboon River, much exceeding in size, and specifically distinct from the previously known *Troglodytes niger*. The existence of this formidable animal in that district was first made known to Professor Owen by Dr Savage, in a letter, dated April 22, 1847, which contained drawings of two skulls obtained by him in that locality; and Professor Owen therefore proposes to call it *Troglodytes Savagei*. The skulls which formed the subject of the paper, were placed in Professor Owen's hands by Mr Stutchbury of Bristol, who obtained them through the assistance of Captain G. Wagstaff, who visited the Gaboon during the past summer. Professor Owen entered into a minute comparison of the corresponding parts of *T. Savagei* and *T. niger*, and carefully established the characters, which prove a true specific difference between them—observing that some scepticism might be expected from naturalists who had not been able to realise those differences by the actual comparison of specimens; but he felt no doubt but that, as was the case of the *Pithecus morio*, more extended knowledge of the new species would confirm the validity of its distinction. In size, the *T. Savagei* excels even the great orang, the skull of the oldest male measuring 11½ inches in length.—*Athenæum, No.* 1062, p. 246, March 4, 1848.

7. *Voices of Birds.*—The voices of birds appear to me (the notion may be merely imaginative) a special adaptation to their localities and habits. Almost all the birds that haunt our coasts, and with the exception, perhaps, of the Anatidæ or ducks, have a low melancholy wail, clear and melodious, but still wild, that appears to be admirably in keeping with the loneliness of the spots they inhabit. Before us lies the wide waste of waters, with here and there a heavy lagging sail, which seems to mock the very idea of life and bustle; around us spreads an unbroken extent of low marshy land, where no trees rear their heads, and where the rush and the sainfoin alone may grow. How beautifully in unison with such a scene is the clear shrill whistle of the curlew and plover, and the wild, hoarse voice of the gull! It makes sadness pleasingly sad, and desolation more desolate, to listen to such sounds amidst such scenery. Who would like to hear them in the neighbourhood of his dwelling, for which the busy chirp of the sparrow, the twittering of the swallow, and the loud clear accents of the danger-defying chanticleer are so well at-

tuned? Copse and woodland covert, hedgerow and orchard, seem made purposely for the clear music of the mavis and merle. With what clear accents burst forth these gladsome notes from every dell and dingle, and how harmoniously they rush through apple-blossoms, and May flowers, and sweet-smelling plants. They render rusticity more rustic, and are the most glorious pœans that could be sung at the revels of luxuriant nature. Birds do not sing in winter amidst gloom, and mist, and thick pelting snow, but reserve their songs for spring and summer, nature's fairest and rosiest holidays. Where shall the skylark find a freer temple for his rich morning song than the blue firmament, with azure above him and emerald shades beneath, and the bright sun-beams sparkling on every plume? Or what hour shall the nightingale choose for her clear calm orisons but the watching hour of eve, when the earth and all its creatures are hushed into a willing auditory? Surely the plover was made for solitude, and the mavis for glad retirement, and the fowl for the barn-door, the skylark for mid-heaven, and the nightingale for dewy eve.—*Summer Evening Rambles.*

BOTANY.

8. *Distribution of Plants.*—If we divide the surface of the globe into botanical provinces, according to the geographical distribution of plants, South Africa will be one of the most distinct and strongly marked of these provinces, although, in proceeding towards the north-eastward, its peculiarities seem to be in some measure shaded off into those of the tropical regions. It would seem that the distribution of plants and that of animals are not governed by precisely the same laws. Le Vaillant, Dr Smith, and Mr Swainson, have shewn that very many birds are common to Senegal and the Cape of Good Hope; whereas, I believe, that these two countries possess not a single flowering plant in common (introduced species being excepted), and scarcely even a genus of plants, with the exception of such as are almost universally diffused. Not a single example of any of the tribes most characteristic of the Cape vegetation was found by Mr Brown in the collections from Congo. The zoology of the Cape, as far at least as the quadrupeds and birds are concerned, would appear to be of a much more thoroughly African type than its botany. A great number of the most conspicuous and characteristic mammalia of the regions near the Cape, are either identical with those inhabiting tropical Africa to the north of the equator, or, if distinct species, they are at least closely allied, and often with difficulty distinguishable.* Not that the Cape has not several peculiar forms, such as the ant-eater (*Orycteropus*), the Gnoo, the Eland, and some of the

* As in the case of the Giraffe of South Africa, which is considered by some naturalists as a different species from that found to the north of Europe.

sub-genera of Antelopes; but its Fauna certainly appears to be much more similar to that of the tropical regions of Africa than its Flora.

In Abyssinia alone, as it would seem, do any of the dominant and characteristic forms of the Cape Flora reappear. The beautiful blue water-lily, indeed, has been supposed to be common to Egypt and South Africa, but the forms of the plant occurring in these two countries are a little different, and are considered by De Candolle as distinct species; their distinctness, however, may perhaps be doubtful.

The vegetation of the Cape is most strikingly different from that of Buenos Ayres in South America, which lies nearly in the same latitude, and has nearly the same mean temperature. It is not merely that the species, the genera, and the prevailing tribes of plants are different, but the whole aspect of the vegetation is dissimilar. A very large proportion of the Cape plants are shrubs; those of Buenos Ayres, are almost entirely herbaceous. Both countries agree, indeed, in the very great scarcity (generally speaking) of trees, a scarcity which is much less surprising on the arid rocks and stony wastes of South Africa, than on the marly plains of the Rio de la Plata. Nearly all the remarkable families of plants which predominate at the Cape, are wanting in the Buenos Ayrean region, where the prevailing forms are a great variety of Nightshades, Tobaccos, *Petunias*, *Nierembergias*, and plants allied to these, numerous *Verbenas*, Amaranths, *Chenopodiums*, Mallows, and Grasses. Some gay flowered plants of the Iris and Amaryllis families, which grow in great abundance on the banks of the Rio de la Plata, are nearly all that shew an affinity to the Flora of the Cape.

On the other hand, the botany of Australia, in the same latitude, seems to have many striking points of similarity to that of the Cape of Good Hope. This similarity appears both in the general external aspect of the vegetation, and in the presence of several remarkable families of plants common to both countries; in particular, the Proteaceæ and Restiaceæ. On the other hand, there is a remarkable difference between them, in the absence from Africa of the Eucalypti, or gum trees, and which constitute the great bulk of the vegetation of Australia.—*Bunbury on the Cape of Good Hope*, p. 220.

GEOLOGY.

9. *Geology and Physical History of the Globe.*—M. Elie de Beaumont communicated a letter from M. Hommaire de Hell, dated Tauris, of the 25th Nov. 1847, and containing different observations and researches already made by him, during a journey in which he is engaged in the country washed by the Black Sea.

He has observed that the volcanic rocks which border the northern part of the Bosphorus, are continued without interruption as far as Kilia and Kirirkaia, to about six leagues of the strait. On this line, as along the other parts of the coast of Romelia and Bulgaria, he has seen no trace of Silurian formation in the sides of the canal. He only found, to the east of Kilia, a very curious formation of sedimentary rocks, the beds of which, highly elevated, appeared to be composed of the same elements as the igneous rocks in contact with them, and which seem to belong to the trachytic family.

M. Hommaire has determined the saltness of the Black Sea, at different points, by means of M. Callardeau's densimeter, and by the more exact method of evaporation, and weighing the containing vessel when empty, full, and with the residuum. The results have been sensibly the same everywhere, and presented scarcely any difference from those of the Bosphorus.

M. Hommaire has sought to verify the existence of a great current which is generally admitted to flow towards the Bosphorus, and which is attributed to the superabundance of the waters which the Danube and the great rivers of Southern Russia discharge into the Euxine sea. He has found no trace of this current, and yet he has sailed along the shores of the Black Sea for upwards of 300 leagues.

M. Hommaire de Hell is likewise occupied with the level of the Bosphorus. An investigation made with the utmost care, by means of a proper instrument, has proved that there is no sensible difference of level between the Black Sea and the Sea of Marmora. From Roumelikavak to Bacta-Liman, a distance of upwards of 13000^{m}, the declivity being towards the south, and while the winds were from the north, it did not exceed $0^{m}{\cdot}0326$.

The observations he has made on the direction and quickness of the currents, at different depths, have indicated a general direction towards the south. He has been struck with the rapidity with which the current sets in towards the south, even to a depth of 25^{m}, as soon as the north winds begin to blow. It might then be said that the waters are displaced in a single mass, throughout their whole height, to be conveyed towards the Sea of Marmora. He has likewise noticed a faint southern current at the surface, diminishing by degrees till it is reduced to zero, to a depth of about 15^{m}, to reappear in the same direction at 18 or 20^{m}, with a celerity tenfold that of the surface. In order to explain this phenomenon, M. Hommaire supposes that there first existed, under the influence of strong winds from the north, a current towards the south, embracing nearly the whole height of the canal. South winds having succeeded these north winds, the current would become completely neutralised in the superior beds; but before the reaction could descend into the lower regions, the south wind would have resumed; hence the new current towards the south, at the surface, and even to a certain depth.

After all these investigations, it seemed of consequence to the author, towards the interest of his researches on the geological revolutions of the basin of the Euxine, to determine whether, in the case of the closing up of the Bosphorus, the waters of the Black Sea, on rising, might find an outlet in the Sea of Marmora, by ascending the valley of Sakaria, and penetrating into the Gulf of Nicomedia, by way of Sabandja. M. Hommaire has, therefore, taken the level to determine the height of the hills which separate the basin of Sabandja from the Propontis. He has found that the least elevated point reached an elevation of $40^{m}\cdot99$ above the level of the Gulf of Nicomedia. The Bosphorus being closed, the waters of the Black Sea might then rise, flow above the plains of Manitch, and unite in the Caspian Sea, without finding any issue into the Sea of Marmora. Such a junction could not, perhaps, take place in the present day, in consequence of the changes which are taking place in the rivers.

The same phenomena which M. Hommaire has remarked on the northern shores of the Black Sea, he has again found on the coast of Bulgaria, Romelia, and Anatolia. Everywhere there exists traces of a greater elevation of level in the waters of the Black Sea. These traces consist of modern deposites rising everywhere nearly to the same height, rarely exceeding from 25 to 30 metres, and containing uninjured marine shells, all the species of which now live in the Black Sea. Unless we suppose a complete and regular rising upwards of all the countries surrounding the Euxine and the Sea of Azof, posterior to all the geological revolutions hitherto indicated, a supposition which, after his own observations, M. Hommaire considers scarcely admissible, we must necessarily have recourse to the notion that the Bosphorus was anciently closed up and burst forth from its boundaries.

M. Hommaire has determined the saltness of lake Van. The densimeter of M. Collardeau gave 102, water being 100. The method by evaporation gave 102, 029.

He concludes by giving the result of his observation, and his calculations of the following latitudes:—

Tauris, ...	38° 04′ 47″·87
Gumuchtlane, . .	40 24 29 ·21
Eguin, on the Euphrates, .	39 12 37 ·31
Kebanmaden, on the Euphrates,	38 44 35 ·80
Kharpout, ...	38 39 37 ·98
Diarbekir . . .	37 54 51 ·58
Bitlis, . . .	Not yet calculated
Van, ...	38 29 23 ·40

10. *Decomposition of Rocks.*—M. Ebelmen's memoir on the subject contains new analyses, made by the author, of rocks in a state of decomposition under the influence of atmospheric agents. In determining in this way the nature and proportion of the elements which disappear by decomposition, the author has endeavoured to confirm the conclusions of a former work. By the comparative analysis of the unchanged and altered rock (consisting of trap, called grey-stone, from the neighbourhood of St Austel in Cornwall, and basalt from the vicinity of Linz), he has ascertained that the silex, lime, magnesia, the oxide of iron, in certain cases, and the alkalies, have a tendency

to separate more or less completely in the decomposition of the rock. Water alone is found in much greater proportion in the decomposed than in the unaltered rock. The produce of the alteration in the rock tends to approach more and more near to a hydrated silicate of alumina, than to a clay. These results are quite in unison with such as he had formerly obtained, and from which he deduced the two following principles, 1*st*, In the decomposition of silicate not containing alumina, we constantly find that the silex, lime, and magnesia, are eliminated. Sometimes, however, the iron remains in the residuum of the decomposition in the state of peroxide, sometimes it disappears with the other bases. 2*d*, In the decomposition of silicates containing alumina and the alkalies, with or without other bases, the alumina is concentrated in the residunm by retaining the silex and fixing the water, while the other bases are carried along with a part of the silex. The final produce approaches more and more to a hydrated silicate of alumina.

Almost all the rocks of igneous origin contain alumina, and consequently, yield an argillaceous residuum by decomposition under the influence of the atmosphere. The author endeavours to shew, in his memoir, that we cannot ascribe the clay of stratified formations to any other origin than the mechanical abstraction of the residua of the decomposition of igneous rocks.

Finally M. Ebelmen examines, at the conclusion of his memoir, one of the most important questions relating to the natural history of the globe, that of the relations which *necessarily* exist between the phenomena of the alteration of rocks and the composition of atmospheric air. "The different bases which separate from the silex by the decomposition of igneous rocks determine, in fact, the precipitation, the mineralisation of the oxygen and of the carbonic acid. The last element, in particular, is absorbed in great quantity, and a simple calculation shews that a small body of decomposed plutonic rocks is sufficient for the complete precipitation of the carbonic acid contained in the air. Now, the argillaceous beds of stratified formations induce the decomposition of immense masses of plutonic rocks; and, consequently, the precipitation of quantities of carbonic acid out of all proportion with those actually existing in the atmosphere. This result may be explained without any necessity of admitting that the air has possessed, in the different geological epochs, a very different composition from which it presents at present.

"I observe, in volcanic phenomena," says M. Ebelmen, "the principal cause which restores to the atmosphere the carbonic acid which the decomposition of rocks continually precipitates from it. We know that this gas is disengaged in abundance from the ground in the neighbourhood of active volcanoes, and even from extinct volcanoes. It is interesting to witness the formation of igneous rocks, accompanied with the disengagement of a gas, which the destruction of these same gases will precipitate. The central heat of the globe will therefore be indispensable for the maintenance of organic life on its surface. The beautiful experiments of Saussure on the influence of the carbonic acid of the air on the nourishment of vegetables, are no longer sufficient to explain the permanence of the composition of atmospheric air. We see that phenomena entirely of a different kind must be introduced for the solution of the question, and that the mineral elements of the crust of the earth likewise concur, by the inverse reactions the one on the other, to produce this equilibrium."—*From L'Institut*, No. *Supplement*, p. 22.

11. *Geological Society, March 8.—Sir H. T. de la Beche in the Chair.—A paper " On the Position in the Cretaceous Series of Beds containing Phosphate of Lime," by R. A. C. Austen, Esq., was read.*—In a letter in the Gardeners' Chronicle of the 19th of February last, Mr Paine of Farnham gives an account of some strata in which phosphate of lime occurs in sufficient abundance to render it of importance to agriculture; and the editor expresses a hope that the notice may lead to the successful search for like underground wealth in other parts of the country. The present paper is written in part-fulfilment of that hope. Many observers, as M. Brongniart, Dr Buckland, Sir H. de la Beche, and Dr Fitton, have noticed the occurrence of phosphates of lime in the gault. The author had also noticed them in his account of the vicinity of Guildford. The important part of the recent discovery is, therefore, only that this substance is so abundant as to have great economic value. Near Guildford, phosphate nodules are abundant in the upper greensand. In the gault below, concretions of phosphate of lime are not so uniformly diffused, but occur in two seams—one in the argillaceous portion of the bed, the other very low in the mass. Both beds are very persistent; but in consequence of the undulations of the strata along the base of the escarpment of the North Downs, it is only a few places that will repay those who may look for this mineral substance, the beds of gault and greensand being often far below the surface. The phosphates have been found beneath Newland's Corner, near Guildford, at Puttenham, and other places. The greensand and gault at Farnham also contain beds productive of phosphates of lime. The nodules have the form of coprolites, but differ from these bodies in internal structure.—*Athenæum*, No. 1064, p. 296.

12. *On the Presence of Phosphoric Acid in the Subordinate Members of the Chalk Formation, by J. C. Nisbet,* was next read.—From the marl near Farnham there was obtained by washing a substance evidently coprolitic, containing 28 per cent. of phosphoric acid, while the general mass contains as much as 2 to 3 per cent. In some nodules from the gault near Maidstone so much as 23 per cent. was also obtained, and some nodular masses of shells from the Shanklin Sands, shewed 15 per cent. of this important substance.—*Athenæum*, No. 1064, p. 296.

13. *On the Fossil Remains of Birds, collected in various parts of New Zealand. By W. G. Mantell, Esq.*—The first relic of the gigantic struthious birds, which formerly inhabited these islands, that was transmitted to Europe, was a small fragment of the shaft of a femur or thigh-bone, only a few inches long, and so much resembling that of an ox, that it was at first mistaken for such by many eminent naturalists. Its true characters were, however, recognised by Professor Owen in 1839, who proclaimed that it belonged to a bird of the ostrich family, but of far more colossal dimensions. This prediction was soon confirmed by more numerous remains, sent home by the Rev. Mr Williams and Mr Earl. On hearing of this discovery, Mr W. Mantell endeavoured to procure some more complete specimens; and in 1846, and the beginning of 1847, explored every known locality where they were found. All the bones previously sent to this country were found embedded in the mud of rivers, and were permeated and coloured more or less deeply by a solution of iron. Those now sent by Mr Mantell occurred in a bed of loose volcanic sand, and are light, porous, of a delicate fawn colour, and with the most fragile processes uninjured; portions of the egg-shells, of the mandibles, and even of the bony rings of the air-tubes being preserved. The volcanic sand has filled all the open cavities of the bones; but, not being at all consolidated, is easily removed by shaking or by a soft brush. The locality is not mentioned on any map of New Zealand, but seems to be near the river Wanganu, which takes its rise in the volcanic mountain of Tongariro, remarkable for its boiling springs. From seven to eight hundred specimens have been sent home, belonging to birds of various size and age. And they indicate the existence of five genera, of which four were previously unknown. In certain mounds, said by the natives to contain the remains of their feasts, Mr Mantell found bones of the moas or gigantic birds, of dogs and men, all mixed up together, and all evidently subjected to the effects of fire. Hence these birds must have lived at the same period with men who, like the present natives, were cannibals. Since the bones were embedded in the alluvial beds, the land seems to have been elevated; several terraces, at different heights above the sea, being seen round the coast. New Zealand has thus, from a very ancient period, been inhabited by a peculiar race of birds, to the almost total exclusion of mammalia and reptiles; thus forming a counterpart to certain geological periods, during which reptiles, either alone or chiefly, prevailed, as in the case of the Galapagos islands at the present day.

14. *On the Organic Remains found in the Skiddaw Slate; with some Remarks on the Classification of the Older Rocks of Cumberland and Westmoreland. By the Rev. Professor Sedgwick.*—Immediately above the granite of Skiddaw Forest is a group of slate-rocks, of great but unknown thickness, and forming hills reaching to 3000 feet in height. Above this is a vast group of green roofing slates, alternating

with feldstone-porphyry, and trappean rocks. Above this, again, are the Coniston limestone, the Ireleth slates, and several other deposites, overlaid unconformably by the old red conglomerate and carboniferous limestone. In reference to the classification of these rocks, it is stated that good physical groups are the foundation of all geology, and the most remarkable monuments of the past history of our globe, so far as it is made out in any separate region. Organic remains are, in the first instance, but accessaries to good sections; though, in comparing remote deposites, they become the primary term of comparison. The Coniston limestone and flagstone, in their lower part, contain true Lower Silurian fossils; all the higher part of the series, till we touch the old red conglomerate, belongs to the Upper Silurian system. The lower deposites, or the green slates and porphyries, with the Skiddaw slates, are the true equivalents of the great Cambrian group of North Wales. The latter, however, contains fossils almost to its very base; whereas the Cumberland beds have never exhibited a single specimen. This rarity of organic remains may have arisen from various causes; but even in 1822, Professor Sedgwick pointed out the existence of carbon in these rocks; and last summer gave Mr J. Ruthven, of Kendal, directions to explore this tract. His search has resulted in the discovery of two species of graptolites, and some fucoids in the Skiddaw slate, which, consequently, is not below the limits of organic life. These fossils belong to the lowest groups; and probably very nearly mark the limits below which life has not extended.—*Athenæum*, No. 1061, p. 218. February 26 1848.

15. *Coral Island.*—Although there is not much variety, there is considerable beauty in a small coral reef when viewed from a ship's mast-head at a short distance in clear weather. A small island, with a white sand beach and a tuft of trees, is surrounded by a symmetrically oval space of shallow water of a bright grass-green colour, enclosed by a ring of glittering surf, as white as snow, immediately outside of which is the rich dark-blue of deep water. All the sea is perfectly clear from any mixture of sand or mud; even where it breaks on a mud beach, it retains its perfect purity, as the large grains of coral are heavy, and do not break into mud, so that if a bucket full of coral sand be thrown into the sea, it may be seen gradually sinking like a white cloud, without producing any discoloration in the surrounding water. It is this perfect clearness of the water which renders navigation among coral reefs at all practicable, as a shoal with even five fathoms water on it can be discerned at a mile distance from a ship's mast-head in consequence of its greenish hue contrasting with the blue of deep water. In seven fathoms water, the bottom can still be discerned on looking over the side of a boat, especially if it has patches of light coloured sand; but in ten fathoms the depth of colour can scarcely be distinguished from the

dark course of the unfathomable ocean.—*Voyage of Her Majesty's Ship Fly, by J. B. Jukes*, p. 10.

16. *Vale of Sharon.*—But I must describe the Vale of Sharon. It is an immense meadow, extending from Mount Carmel to Joppa on the coast, and bounded on the east by the great chain of barren-looking hills, among which is situated the Holy City. It is an area of perhaps twenty miles square, of beautiful rich lowlands, planted, in many places, with olive and fig orchards, and grazing plats, upon which herds of goats and cattle were browzing. In all this beautiful valley there is not a single fence or wall, and the park-like effect of the groves and valleys is very lovely. It struck me that, in the hands of skilful husbandmen, it might be a paradise. Several Arab villages of brown mud cottages, with tall date-trees intermingling, and ruins of ancient elegance, as arches of aqueducts, fountains, and causeways, are scattered over the plain; and huge reservoirs of water, with convenient fountains for the traveller, are pleasant, shady spots, which the lingering heat of the sun made exquisitely welcome to us. There is no feature of eastern scenery so beautiful as these fountains, generally of solid masonry, with arching domes, and deep niches, huge stone-basins, and cool porticoes, with carved stone-ottomans, upon which the weary pilgrim may freely repose his limbs; large carob-trees and thick shady figs spread their huge limbs over the approaches, and the cool shade is dark and pleasant from the garish sun. We had ridden six miles, when we arrived at the second of these diamonds of the plain. We found a small caravan reclining under the trees; the camel-drivers were adjusting the panniers, urging the patient beasts to lift their huge forms, and low, melancholy cries were groaned forth as they rose under their burdens. A herd of goats, probably two hundred in number, was also just leaving the fountain to continue their way toward Jaffa; and the swarthy, half-naked herdsmen were occupied in keeping the flock together on the way. Arab women were drawing water, and carried Rebecca-looking jars on their heads. Several dismounted Arabs reclined under the cool portico; and the whole picture, in architecture, costume, habits, and scene, was unchanged since 1800 years. Our Arab guard came first along, and took their position a little beyond the pools; the officers came in turn, drew out their drinking cups and flasks, and man and beasts took long and copious draughts of the refreshing springs. This fountain has left delightful impressions: it was a gay and joyous pausing place; and eyes fond of pictures, and hearts fond of recollections, had ample occupation.—*Shores of the Mediterranean, by Schrveder*, vol. i., p. 193.

HYDROGRAPHY.

17. *Gradual Diminution of Temperature of the Air and the Sea as we approach the Land.*—This evening we observed a gradual diminution of the temperature of the air and the sea as we approached

the coast of Africa; and before midnight we entered a cold mist which prevented our seeing to any considerable distance; the water appearing discoloured, we tried for, but did not obtain soundings, with 130 fathoms of line.

By 1 P. M. the next day, the temperature of the sea had fallen from 70° to 56°·5, that of the air being 65°, and the mist unpleasantly cold to our feelings. We were at this time in lat. 32° 21′ S., long. 17° 6′ E., therefore, about forty-five miles from Paternoster Point, when we struck soundings in 127 fathoms on a bed of fine dark sand. We had expected to have found an *elevation* in the temperature both of the air and sea on our approach to the African coast, by reason of the radiation of heat from its shores; but the cause of the depression became evident on the morning of the 9th, when, having sighted Cape Paternoster at daylight, we found we had to contend against a current increasing in strength and coldness of temperature as we neared the land. The existence of a body of cold water rushing from the eastward, round the Cape of Good Hope, has long been suspected; but its extension so far to the northward, has not, I believe, been before noticed. As we were several days beating up to the Cape, we collected the following curious facts respecting it. Thus, on the 7th, when distant 120 miles from the coast, and before we perceived the effects of the current, the temperature of the air was 71°, that of the sea 70°, and the depth of water more than 400 fathoms, which, being placed in order, will serve to explain the arrangement of the following table:—

No.	Date.	Distance off Shore.	Temperature.		Depth of Water.	Remarks.
			Air.	Sea.		
		Miles.			Fms.	
1	7	120	71°	70°	400	No Soundings.
2	8	90	65	63	130	No Soundings.
3	...	45	65	56	127	Temp. at that depth 45°.
4	...	10	59	54	65	
5	9	10	59	54	47	
6	10	60	64	61	200	Temp. at that depth. 43°·5.
7	...	20	61	55	130	
8	11	52	67	64	203	
9	...	32	60	54	142	
10	12	51	69	66·5	313	
11	...	36	67	67	202	
12	...	27	58	54·5	72	
13	13	7	63	55	58	
14	...	4	59	51·5	48	
15	14	27	62	57·5	115	
16	15	6	55	51	76	WNW. from Cape.
17	16	11	66	62	190	WSW. from Cape.
18	17	4	65	60	37	In False Bay, SE. from Cape.

By a careful examination of the above experiments it will be manifest that the distance to which the cold water extends from the coast, depends materially upon the depth of the soundings. It barely reaches 40 miles from the shore, where the sea is more than 300 fathoms deep, but spreads over double that distance in the shallower parts. At 45 miles from the land, and at a depth of 120 fathoms, the temperature was found to be 45°, that of the surface being 56°, and at 60 miles off the land, at 200 fathoms, it was 43°·5, the surface being 61°.

All these circumstances combine to shew that a northerly current of very limited extent, but of considerable force, exists from the Cape of Good Hope along the western coast of Africa; which, in general terms, may be represented by a volume of water 60 miles wide, and 200 fathoms deep, averaging a velocity of about a mile an hour, and of the mean temperature of the ocean, running between the shores of Africa and the waters of the adjacent sea. The cloud of mist which hangs over this stream of cold water, is occasioned, of course, by the condensation of the vapour of the superincumbent atmosphere, whose temperature is generally so many degrees higher than that of the sea. It is sufficiently well defined to afford useful notice to seamen of their near approach to the land.—*Sir James Ross's Voyage to the Southern Seas*, vol. i., p. 32.

ARTS.

18. *On the Curiosities of Glass Manufacture. By Mr A. Pellatt.*—In ancient as in modern glass, sand was the base, and alkali the solvent, and the injury occasioned to the glass by an excess of the latter ingredient was pointed out. That opacity of glass called *devitrification*, was explained as consisting in the formation of a multitude of minute crystals, in close contact with each other, on the surface of the glass. The process of annealing was then described; and it was shewn that a glass-tube forty inches in length contracts, if annealed, a quarter of an inch; while an unannealed tube of the same length contracts but one-eighth of an inch. The most interesting part of Mr Pellatt's discourse referred to the mode of making *Vitro di Trino,* and of impressing heraldic devices, &c., on glass. In the case of Vitro di Trino, the gathered glass, after being expanded into a bulb or cylinder of the required size, has rods of other glass or enamel attached to it in a vertical position, at equal distances all round, and then, the bottom being held, the top part is more or less turned, so as to give an equally inclined twist to the vessel and the rods. A similar but larger vessel is made; but which is also turned inside out, and then the former is put into the lathe; and, being expanded by blowing, the two come together, and adhere by the rods and their intersections, but inclose small portions of air, which, being regular in size, form, and disposition, give the character of the glass. When heraldic devices, &c., are to be impressed, a mould of the de-

sign is made in a fit earthy material (being puzzolana, or one of the volcanic deposites), and this is placed within, and forms part of, the larger iron mould, in which the decanter is blown. When the large mould is removed, the earthen portion still adheres to the glass and continues in its place until the bottle is finished. After the annealing, the mould is moistened with water, and immediately separates, and the impression is found really perfect.—*Royal Institution Proceedings.*—*Athenæum*, No. 1061, p. 220, February 26, 1848.

19. *House Painting.*—M. Leclaire, house-painter, calls the attention of the Academy to a substitution which he daily makes of the white of zinc and colours with a zinc base, for white-lead and colours with a base of copper and lead, in the arts, and for ordinary purposes.

In his daily practice, M. Leclaire employs the white of zinc, which appears to possess all the qualities of white-lead, without any of its inconveniences. Thus, if we must give credit to his statements, and the results are of sufficient standing to render it easy to verify them, zinc-white is much whiter than white-lead; ground and used with oil, it reflects the light, instead of absorbing it: it furnishes finer and more transparent tones, it covers better, and with equal weights, a larger space; it remains unchanged by sulphurous fumes, which immediately blacken objects painted with lead; finally, the manufacture and use of zinc-white has no injurious effect upon the health. But all this is not sufficient for the complete solution of the problem. In fact, although zinc-white was known in science, it has never been collected hitherto but as a produce of the laboratory. It was necessary to obtain it in quantities and at an accessible price. Then, once obtained and mixed with oil, it was necessaiy, in order to apply it readily to painting, that it should be made to dry easily. Now, the only drying substances we knew had a leaden base, and thus communicated all the defects of lead to the zinc-white. M. Leclaire has obtained a drying substance with a manganese base, which has the property of drying zinc-white more readily than litharge could do.

This was not all. White tones form, so to speak, a kind of exception in painting. Some of the colours most in use are extracted from lead and copper, and owe to these metals the defect of being alterable by sulphurous gases; mingled with zinc-white, they deprived it of the advantage of being unalterable. It was necessary, therefore, to render the process complete, and its application common, to substitute colours which undergo no change for all these alterable colours. After many years of research, says M. Leclaire, I have succeeded in producing, if I may use such an expression, the commencement of a reformation in painting, by completing the scale of unalterable colours—by the substitution of inoffensive and unalterable colours for all such as had lead or copper for their base, so that I can now affirm, 1st., That the health of a great number of men may be saved without any detriment to the profession; 2dly, That the interior and exterior of houses may be painted without the least risk of the colours changing or blackening by sulphurous emanations; 3dly, That pictures will be no longer liable to change their appearance and harmony with the lapse of time, as has happened with so many pictures of the old masters.

M. Leclaire constantly employs about two hundred workmen in Paris. From the time that he substituted zinc-white for white-lead, not only has he never had a case of lead-colic, but he affirms that no indisposition has at any time appeared among his workmen which can be attributed to their profession. The work has been entrusted to the examination of a commission.—*From L'Institut, No.* 734, January 1848, p. 30.

19. *Preparation of a Substitute for Horn. By M. Rochon.* (Voigt. Mag. de Naturk. und Revue Scient., Feb. 1846, p. 256.)—In many of the arts, more especially where steel instruments are manufactured, glass windows are of great inconvenience, owing to frequent breakage by fragments of steel. The substitution of horn is attended with some inconvenience, principally on account of its want of transparency. A substitute is proposed to be made by very light cloth or wire-gauze, composed of fine brass wire, which is to be immersed repeatedly into a solution of isinglass until all the meshes are filled, and a sufficient thickness acquired, after which it is covered with a coat of copal or other varnish to protect it from the weather.

20. *On the Colouring Principles of some of the Lichens. By Dr J. Stenhouse.*—The lichens, it is well known, yield no colour to water; and it is difficult to imagine how the Celtic inhabitants of the Highlands of Scotland were led to look to so unpromising a source for some of the brightest colours which they have long imparted to their national tartans. The father of the late C. Mackintosh and his partner, Mr Cuthbert Gordon, first added them to the chemical arts, about the middle of the last century, probably availing themselves of the indigenous processes; and the article known by the name of Cudbear (a corruption of the Christian name of Mr Gordon) is still manufactured by their representatives in Glasgow. The researches of Heeren, Dumas, Kane, Schunck of Manchester, and other chemists, led to the discovery of several organic principles in these lichens, chiefly of a neutral or acid character, themselves colourless, but converted by ammonia into the delicate reds and purples of archilo, litmus, and Cudbear. Dr Stenhouse has been enabled to add largely to the number of these principles, and to illustrate their singular relations, chiefly from having discovered the proper mode of extracting them from the lichens; which is by means of hot-water and lime, and not by means of boiling water, as hitherto practised. Plants, botanically the same, but from different localities, are here found to

yield chemical principles, allied in character, but of different composition; shewing that the organic nature is even more prolific in chemical than in botanical species. From a South American variety of *Roccella tinctoria* Dr Stenhouse obtains new acids, named by him *Alpha-orsellic* and *Alpha-orsellesic*; from a Cape of Good Hope variety. *Beta-orsellic* and *Beta-orsellesic*, and a neutral principle Roccellinin. The *Evernia prunastri* yielded evernic and evernesic acids, the *Usneas* usnic acid, &c. The author recommends that the extraction of the colouring principles should be performed in the countries where the lichens grow, by cutting them up into small pieces, macerating in milk of lime, neutralising the solution obtained by muriatic or acetic acid, collecting the gelatinous precipitate which falls on cloths, and drying it at a gentle heat. Thus the carriage of the original bulky lichen would be, in a great measure, saved. The commercial value of these lichens also varies excessively, according to the proportion of colouring matter producible from them. This, he finds, may be accurately determined for trade purposes, by macerating a constant weight of the lichen in milk of lime, filtering and adding a solution of bleaching powder of known strength, from an alkalimeter, till all colour disappears, and noting the quantity of solution required. He thus found samples of the following lichens to have proportional values assigned to them:—

Angola lichen . .	required 200 measures,	value 1·00
American . . .	... 120 ...	... 0·60
Cape	... 35 ...	... 0·17
Lecanora Tartarea (Giessen)	... 25 ...	... 0·12

—*Athenæum*, No. 1061, p. 217, February 26, 1848.

21. *Stereochromy.*—A communication from Professor Schottlauer, of Munich, acquaints us with particulars of a new invention for painting upon walls, discovered by himself, conjointly with Herr Fuchs, Counsellor of the Mines, to be called stereochromy. Its peculiarities are stated as follows:—Far greater ease in its manipulation than fresco. The ground is not laid in patches, but by one single operation. The colours, prepared in distilled rain-water, take such firm hold as not to be disturbed or altered by any subsequent washings or shades, while the process of painting may be carried on with any amount of intervals, thus rendering a far richer finish possible than with fresco, After the picture is finished, it is saturated with a fluid, which unites the ground and the colour into a mass of the consistency of stone, desiccation being thereby rendered impossible. The colours are of greater strength and brightness than with fresco, though without the slightest glare or reflection, as of oil. It resists all atmospheric influences, humidity, evaporation, &c.; a test, no less extreme than the burning of alcohol has been applied to it, without the slightest change or deterioration.—*Athenæum*, No. 986, p. 820.

22. *Melon Wine.*—A paper was received by the Paris Academy of

Sciences, from M. Boucharett, on the culture of the vine, and the fabrication of wine. The author gives hints as to the kinds of vine proper to different soils, and the mode of cultivating them; and speaks also of various other vegetable productions from which wine might be made. The melon, he says, is one of the best; it yields an excellent white wine, which will keep for several centuries, and, properly cultivated, may be made to render a handsome profit.

NEW PUBLICATIONS RECEIVED.

1. A Description of Active and Extinct Volcanoes, of Earthquakes, and of Thermal Springs. Second Edition, much enlarged. By Charles Daubeny, M.D., F.R.S., &c. &c. London, R. and J. E. Taylor. 1848. *Dr Daubeny, one of our most intelligent geologists, in this new edition of his celebrated work, brings all the descriptive and the theoretical branches of volcanic geology up to the present time. It is now the classical English work on volcanoes.*

2. Generum et Specierum Mineralium, Secundum ordines Naturales Digestorum Synopsis. Scripsit Ernestus Fridericus Glocker. Halle. 1847. *The work of a learned Mineralogist, well deserves a place in our Mineralogical Libraries.*

3. Geologie von Dr Gustav Bischof. Vol. i. and vol. ii.; Part 1st. Bonn. 1847. *As this important treatise is only in progress, we delay our opinion in regard to it at present.*

4. Outlines of Physiology. Part. 1. By Professor Allen Thomson. Maclachlan, Stewart, & Co., Edinburgh. 1848. *One of the best English Text-Books of Physiology. It will take its place beside the well arranged Text-Books of the late Professor Playfair and the present distinguished Dr Alison.*

5. Physiologische Briefe fur Gebildete Aller Stände Von Carl Vogt Stuttgart und Tübingen. 1847.

6. H. G. C. Clarke's Address to the Members of the Berwickshire Naturalists' Club. Alnwick. 1847. *We once a year receive, and with pleasure, from the Berwickshire Club, the Annual Report of their peripatetic peergrinations. All those in this part of Scotland who enjoy health, will find it a delightful recreativn to join the naturalist pedestrians of Berwickshire.*

7. Historia Naturalis Orcadensis.—Zoology. Part I. By B. W. Baikie, M.D. and R. Heddle. Edinburgh. 1848. *The Natural His-*

tory of the Orkneys [Seal Islands of ancient writers] promises, from the manner in which this first part is got up, to be fully and accurately described by Messrs Baikie and Heddle of Orkney.

8. The Natural History of the Human Species. By Lieut.-Colonel Charles Hamilton Smith, K. H. Edinburgh. W. H. Lizars. 1848. *Colonel Smith, so well and favourably known as a Naturalist and Artist, in this beautifully illustrated volume displays his usual extensive knowledge of his subject. Although we must differ from the intelligent Author in some of his views, we are not the less disposed to recommend it, particularly to Students of Anthropology.*

9. Bemerkungen uber Gyps und Karstenit. Von Professor Joh. Freidr. L. Hausmann. Gottingen. 1847. *This celebrated Memoir so much prized by Philosophical Mineralogists and Geologists, we advise those of our readers not already familiar with it to study carefully.*

10. Mineralogie und Geognosie. Von Professor F. X. M. Zippe. Prag. 1846. *Professor Zippe in his work, advocates the geognostical views, and also the mineralogical system of the late celebrated Professor Mohs.*

11. Dr E. Vogt's Geologie. Vols. i. and ii. Braunschweig. 1847. *This amusing and instructive work professes to contain the author's own geological experiences and the views of Elie de Beaumont, as delivered in his lectures on Geology.*

12. A Stratigraphical Account of the Section from Atherfield to Rocken End, Isle of Wight. By William Henry Filton, M.D., F.R.S., &c. London. R. &. J. E. Taylor. 1847. *This admirable account and section afford ample proofs of the accuracy, skill, and indefatigable perseverance of our friend and former pupil Dr Filton.*

13. Lehrbuch der Physikalischen Geographie und Geologie. Von B. Studer, Doctor and Professor in Bern. Vols. i. and ii. Bern, 1847. *As the Ray Society has done good service to science by its various well-selected and useful publications, we presume to recommend, as one of their series, a translation of Professor Studer's admired work on Physical Geography and Geology. Mr Tulk, who has added to our English literature, through the Ray Society, an admirable translation of a celebrated work, viz. Oken's Elements of Physiophilosophy, would, we are convinced, be equally successful with a translation of Professor Studer's two volumes.*

14. Erichson's Archiv fur Naturgeschichte, up to 1848. Berlin.

15. Jahres Bericht. Von Jacob Berzelius fur 1847.

16. L'Institut up to February 1848.

17. Leonhard and Bronn's Jahrbuch der Mineralogie und Geognosie, up to 1848.

18. The Journal of Agriculture and the Transactions of the Highland and Agricultural Society of Scotland, up to March 1848. W. Blackwood & Sons, Edinburgh.

19. Journal of the Asiatic Society of Bengal up to November 1847, inclusive.

20. Mineralogie von Franz von Kobell. Nürnberg. 1847.

21. Geognosie, von Dr Philipp von Volger. Wien. 1847.

22. Bericht Uber die Mittheilungen. Von Freunden der Naturwissenschaften zu Wien. Von William Haidinger. 1st Band, from May to October 1846, inclusive. *A valuable record of the proceedings of a new and very promising Association.* 1847.

23. Professor Poggendorf's Annalen der Physic und Chemie, have not been received for many months.

24. The Journal of the Indian Archipelago and Eastern Asia. N. 1. to 7. Singapore, Printed at the Mission Press. 1847. *This new periodical does honour to the editor and intelligent gentlemen associated with him, and promises to open up a new and rich field to the Natural Historian, and to the cultivator of the Statistics of India.*

List of Patents granted for Scotland from 22*d December* 1847 *to* 22*d March* 1848.

1. To Robert Wilson, of Greenock, in North Britain, Master of Arts, "improvements in certain kinds of rotatory engines, worked by steam or other elastic fluids, part of which improvements are applicable to rotatory engines worked by water or by the wind; also an improvement in safety-valves for steam-boilers."—29th December 1847.

2. To William Edward Staite, of Lombard Street, in the city of London, gentleman, "certain improvements in lighting, and in the apparatus used therein, parts of which are applicable to other useful purposes."—31st December 1847.

3. To George Alexander Millar, of Piccadilly, in the county of Middlesex, "improvements in lamps."—5th January 1848.

4. To George Ambroise Michant, of Epieds, in the kingdom of France, gentleman, now residing at Gerrard Street, Soho, in the county of Middlesex, "improvements in the production and application of heat, and in the manufacture of coke."—10th January 1848.

5. To Hector Sandeman, of the Tulloch Bleach-field, in the county of Perth, bleacher, "certain improvements in the materials and processes employed in dressing, clearing, scouring, and bleaching, certain textile fabrics, and the materials of which such fabrics are composed."—25th January 1848.

6. To Robert Weare, of Argyle Street, Birkenhead, in the county of Chester, watch and clock-maker, " improvements in clocks or time-keepers."—25th January 1848.

7. To William Watson Pattinson, of Felling, near Gateshead, Durham, chemical manufacturer, " improvements in the manufacture of soda."—27th January 1848.

8. To Stopford Thomas Jones, of Stamford Street, in the county of Surrey, lieutenant in Her Majesty's service, " improvements in steam-engines, and in machinery for propelling vessels."—27th January 1848.

9. Richard Roberts, of Manchester, in the county of Lancaster, machinest, " certain improvements in machinery for preparing and spinning cotton and other fibrous substances."—28th January 1848.

10. To William Baines, of Norwich, inspector of railways, improvements in the manufacture of parts of railways, and in bearings of machinery, and in apparatus used in constructing railways."—1st February 1848.

11. To Thomas Lambert, of the New Cut, Blackfriars Road, in the county of Surrey, brassfounder, and Charles William Rowley Rickards, of Charlotte Street, Blackfriars, engineer, " improvements in water-closets, and in cocks for drawing off liquids and gases."—1st February 1848.

12. To William Thomas of 129 Cheapside, gentleman, " certain improvements in stays, which improvements are applicable to other useful purposes," being a communication from a certain foreigner residing abroad.—3d February 1848.

13. To George Henry Bursill, of Hornsey Road, in the county of Middlesex, engineer, and Joseph Bradford, of Maida Hill, in the county of Middlesex, gentleman, " improvements in envelopes, wrappers, and covers, and in machinery and apparatus for the manufacture thereof."—3d February 1848.

14. To George Ferguson Wilson, of Belmont, Vauxhall, in the county of Surrey, gentleman, " improvements in treating and manufacturing cer-

tain fatty or oily matters, and in the manufacture of candles and night lights."—3d February 1848.

15. To HENRY BESSEMER, of Baxter House, Old St Pancras Road, in the county of Middlesex, engineer, "improvements in the manufacture of plates, sheets, or panes of glass."—3d February 1848.

16. To WILLIAM THOMAS, of 129 Cheapside, gentleman, being a communication from abroad, "certain improvements in stays, which improvements are applicable to other useful purposes."—3d February 1848.

17. To JOHN HARVEY SADLER, of Holbeck, Leeds, in the county of York, Scotch iron-merchant, "improvements in constructing bridges, aqueducts, and similar structures."—4th February 1848.

18. To AIME BOURA, of Rathbone Place, in the county of Middlesex, dyer and scourer, "improvements in extracting colouring matters."—7th February 1848.

19. To JOHN FREDERICK BATEMAN, of Manchester, in the county of Lancaster, civil engineer, and ALFRED MOORE, of the same place, civil engineer, "certain improvements in valves or plugs for the passage of water or other fluids."—7th February 1848.

20. To WILLIAM LONGMAID, of London, gentleman, "improvements in the manufacture of alkali and chlorine."—8th February 1848.

21. To THOMAS HANCOCK, of Stoke Newington, in the county of Middlesex, Esquire, "improvements in fabrics elasticated by gutta percha, or any of the varieties of caoutchouc."—11th February 1848.

22. To GODFREY ANTHONY ERMEN, of Manchester, in the county of Lancaster, cotton-spinner, "certain improvements in machinery or apparatus for twisting cotton, or other fibrous substances."—18th February 1848.

23. To ALFRED VINCENT NEWTON, of the Office for Patents, 66 Chancery Lane, in the county of Middlesex, mechanical draughtsman, "improved machinery for manufacturing shot and other solid balls," communication from abroad.—18th February 1848.

24. To CHARLES HANCOCK, of Brompton, in the county of Middlesex, gentleman, "improvements in the preparation of gutta percha, and in the application thereof, alone and in combination with other materials, to various manufacturing purposes."—25th February 1848.

25. To THOMAS POTTS, of Birmingham, brass-tube maker, "improvements in the manufacture of tubular flues of locomotive and other steam boilers."—28th February 1848.

26. To EDWARD NEWMAN FOURDRINIER, of Chiddleton, in the county

of Stafford, paper-manufacturer, " improvements in apparatus to be used for raising and lowering weights from mines, and other places."—3d March 1848.

27. To David Williams Wire, of No. 9 St Swithin's Lane, in the city of London, gentleman, " an improved manufacture of candles and other like articles, used for affording light," communication from abroad. —3d February 1848.

28. To John Platt, of Oldham, in the county of Lancaster, machine-maker, and Thomas Palmer, of the same place, mechanic, " certain improvements in machinery or apparatus for making cards; also for preparing and spinning cotton and other fibrous materials; and for preparing and dressing yarn, and weaving the same."—6th March 1848.

29. To James Naysmith, and Holbrook Gaskett, both of Patricroft, in the county of Lancaster, engineers, " certain improvements in machinery or apparatus for forging, stamping, and cutting iron, and other substances."—6th March 1848.

30. To George Edmund Denisthorpe, of Leeds, in the county of York, manufacturer, " improvements in roving and spinning wool and flax, and in treating wool previous to spinning, and in heckling flax."—7th March 1848.

31. To John Tharg Harradine, of Holywell, Cunaheedingworth, in the county of Huntingdon, farmer, " an improved agricultural instrument for preparing land in various ways for agricultural purposes."—9th March 1848.

32. To James Lochhead, of Milton, Gravesend, in the county of Kent, " certain improvements in ventilation."—13th March 1848.

33. To John Lawson, of Paisley, North Britain, woollen shawl printer, " improvements in machinery for separating burs, seeds, and other foreign matters from wool, cotton, and other fibrous substances, being a communication from abroad."—15th March 1848.

34. To William Beckett Johnson, of Liverpool, in the county of Lancaster, engineer, " certain improvements which are applicable to locomotive, stationary, and marine steam-engines."—17th March 1848.

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END OF VOLUME FORTY-FOUR.

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