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THE PROGRESS OF DISCOVERY IN NATURAL PHILOSOPHY, CHEMISTRY, NATURAL HISTORY, PRACTICAL MECHANICS, GEOGRAPHY, NAVIGATION, STATISTICS, AND THE FINE AND USEFUL ARTS,

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Art. I.—*Historical Eloge of* Abraham Gottlob Werner, *read at a sitting of the Royal Institute of France.* By M. Le Chevalier Cuvier, Perpetual Secretary to the Royal Institute of France, &c. &c. &c.

The end of the seventeenth century saw a new science arise, which assumed, in its infancy, the proud name of the Theory of the Earth. Setting out from a small number of ill-observed facts,—connecting these together by fantastical suppositions,—it pretended to remount to the origin of worlds, to amuse itself, as it were, with them, and to form a history of them. Its arbitrary methods, its pompous language, all seemed to disunite it from the other sciences; and in fact, philosophers by profession excluded it, for a long time, from the circle of their studies.

At last, after a century of ineffectual attempts, it has entered within the limits assigned to the human mind. Submitting itself to the modest occupation of observing the globe as it actually exists, it has penetrated into its bowels, and has made a kind of dissection of it. From that period, it has taken its place among those departments of knowledge that are positive; and, what is very remarkable, it has done so, without losing any thing of the marvellous which it had always possessed.

The objects which have been given to it, to see and to touch, —the truths which it has every day been placing under our eyes,—are more admirable and more surprising than any which rash imaginations had amused themselves with conceiving.

Two celebrated men, Pallas and Saussure, had prepared the way for this happy reform,—a third has accomplished it,—I mean Werner. With him, the most remarkable epoch of the science of the Earth commences; and we may even say, that he alone has filled that epoch. For he has had the good fortune to see those ideas, which were so novel, and those views, which, before his time, were so unknown to naturalists, universally prevalent during his own life. He has left as many inheritors of his methods and his doctrine, as there are observers in the world; and wherever mines are explored, or the history of minerals is taught, some distinguished man is to be found, who boasts of having been his disciple. Entire academies have been formed, which have taken his name, as if they had wished to invoke his genius, and to make him, in a manner before unknown, their patron.

On hearing of such extraordinary success, who would not suppose, that it had belonged to some of those keen propagators of their own doctrines, who have overwhelmed their contemporaries by numerous and eloquent works, or who have acquired partizans by the ascendancy of great riches, or of an elevated rank in the social order? Nothing of all this was the case with Werner. Confined to a small town of Saxony, and destitute of any authority in his own country, he had no influence on the fortunes of his disciples. He had no connection with persons in power. Of a disposition singularly timid,—at all times unwilling to write,—he has left behind him but a few sheets of print. Far from seeking to make himself of consequence, he was so little sensible of his own merit, that the trifling rewards granted him at a time when his fame was spread throughout all parts of the world, surpassed to a great degree whatever he had hoped for or desired.

But this man, so little occupied with himself,—believing himself so little called upon to write, or to instruct others, had in his language and in his conversation an indefinable charm. When once any person had listened to him,—when, over some fragments of stones or of rocks, arranged almost by accident, he had developed, as it were by inspiration, all those general conceptions, all those innumerable relations which his genius had discovered, it was impossible to detach one's self from him. The scholars of Werner, subdued by his talent, respected him as a great master,—allured by the affection which he shewed for them, they often cherished him as a father,—wherever they went, they propagated his doctrine, and spoke of his person with respect and with tenderness.

It was thus, that in a few years the small school of Freyberg, intended only at first to form some miners for Saxony, renewed the spectacle of the first Universities of the middle ages,—that scholars flocked to it from every country in which any civilization exists,—and that, in the most distant countries, men far advanced in life, and philosophers who had already obtained celebrity, were seen addressing themselves to the study of the German language, solely that they might be in a condition to hear, in their own person, this great oracle of Geology.

A fame so rare, has deservedly placed Werner on the list of our foreign associates;—it demands this day this tribute of our regrets;—it will dispose you, I doubt not, to listen with some indulgence to the history of a life, altogether secluded,—altogether devoted to science,—perhaps altogether monotonous,—but the labours of which have been rewarded by such great renown.

Abraham Gottlob Werner was born on the 25th September 1750, at Wehrau on the Queiss, in Upper Lusatia. From his earliest years, he saw himself surrounded by objects which were to form the occupation and the glory of his life. His father, who was the director of a forge, used to give him brilliant minerals of different sorts as playthings; and before he could pronounce their names, the child had accustomed himself, whilst occupied in heaping, in throwing, or even in breaking them, to compare them together, and to recognise them by their more marked appearances.

From that time, he kept during his whole life, some of those specimens; and when he shewed his collection, after it had become one of the richest in Europe, he never failed to point out these small beginnings of it, as if he had wished to express a sort of gratitude to those first sparks from which such great lights had proceeded.

He was intended for the employment of a miner; and as the regulations of Saxony require that those who are to enter on this branch of service should be regularly licensed, he proceeded, after having attended a course of Metallurgy at Freyberg, to follow out that of Jurisprudence at the University of Leipsic.

Two tastes,—we might even say two passions,—attended him through life,—the love of minerals, and the love of method. He was fond of dividing, and of classifying objects, as well as ideas. He was pleased with all those things which could be disposed in regular order; and from this period of his life, he used to purchase books, more for the purpose of arranging them according to a plan, than that of perusing them.

This double propensity was observable in his first work, the Treatise on the External Characters of Minerals, a pamphlet of a few sheets, which he published at Leipsic, at the age of twenty-four.

This work is an analysis and minute subdivision of all the varieties in the apparent properties of minerals; every one of these varieties is marked by a fixed term; and the whole of these terms was intended to form a definite language, by means of which all mineralogists might understand one another.

This was to render Mineralogy a service similar to that which Linnæus had rendered to Botany; but it was a service purchased at the same expence.

It is certain, that this Vocabulary has given more detail and more precision to the science: those who take the trouble to apply it, acquire a surprising facility of distinguishing minerals at first sight; and the attentive examination which is necessary to accommodate the description of these substances to the prescribed formula, has led to the discrimination of many of them, which would otherwise, perhaps, have long remained confounded in the crowd. Yet one cannot help confessing that this idiom, which is necessarily pedantic, and which is confined in its terms of expression as well as in its words, has given to those works which have too servilely employed it, an air of pomposity,—a dryness and a tediousness which are more frequently fatiguing than useful.

These inconveniences, however, were never greatly felt. Technical and semi-barbarous terminologies had been long in fashion. For thirty years the fascinating science of Botany had employed no other language, and Naturalists, already accustomed to so many fetters, were not dismayed by the fear of submitting to another.

We might almost believe, that if any one was dismayed by this new creation, it was Werner himself, and that if he wrote so little after his first Essay, it was that he might escape the trammels which he had imposed upon others. Fortunately this performance, accommodated as it was to the taste of his nation, became a source of fame to himself, and procured for him the means of communicating his ideas in a manner less troublesome to him.

In 1775 he was appointed Professor and Inspector of the Cabinets at Freyberg. It thus became his duty to devote himself without interruption, to that which formed the most lively of his inclinations,—and he was stationed in that canton which was best adapted to satisfy his wishes,—that canton, indeed, of all Europe, in which the greatest variety of minerals is produced, and which has been traversed in all directions, for the greatest length of time, by the labours of miners.

Accordingly, from this period, all his labours were devoted to one object,—to Mineralogy. But this single science, made fruitful by his genius, has become a science of immense extent.

His first step had been to create for it a language; his second necessarily was to form for it a Method. But this second step, which was by much the most important, was also by far the most difficult.

Organised existences have two bases of classification evidently given them by nature,—that of the Individual resulting from the union of all the organs of the body to produce some common action; and that of the Species, resulting from the connections which generation has established among individuals.

More remote resemblances, however natural the relations on which they are founded may be, are always more or less dependant on *abstractities* of the mind.

In mineralogy, classifiers have sought in vain for some principle which might correspond in all respects with these primary bases. The mysterious power of crystallization is the only one which seems to have some resemblance with the generative power; it even determines the composition of a body, although it does so only within certain limits. Recent experiments have shewn, that there are substances whose crystallizing power is such, that they constrain very considerable quantities of different bodies to accommodate themselves to their form; and it has long been observed in nature, that crystals in all respects are alike; those of sparry iron, for instance, may contain more or less of iron, or more or less of lime, as there may be in two animals of the same species a greater or less quantity of fat, of gelatine, or of the earth of bones.

In mineralogy, then, crystallization ought to be the fundamental principle of the species, of the visible species. But in an immense majority of minerals, the crystalline form is not apparent, and in these cases composition cannot give us this principle, for the composition of such bodies varies still more than that of crystals, and foreign mixtures more easily corrupt their purity.

What then is to be done? We must have recourse to those properties which are most nearly allied to the fundamental principle,—to the cleavage, which is but one of its phenomena, to the fracture, to the hardness, to the lustre, to the effect of the body on the touch, which are its more or less immediate consequences.

This is what Werner has done, not perhaps that he has exactly proceeded upon these reasonings, but he has done it by that sort of delicate instinct which was the peculiar character of his genius. He has the air of considering the identical composition of the molecules as the principle of species, and the point from which he sets out,—perhaps because he really believed himself to have set out from thence; but he never actually applies this principle, except when it is in agreement with the external qualities, and in all cases it is upon these properties that he has founded his distributions, leaving analysis to reconcile itself to them as it may. All the unctuous stones, for instance, are classed in the Magnesian Order, although many of them contain more alumina or silica, than magnesia. He carried this rule so far, that he always persisted in leaving the diamond among the siliceous stones, notwithstanding the incontrovertible experiments which prove that this gem is only a crystallization of carbon. What is more remarkable, is, that among all these external properties, the one on which he bestowed the least attention, was the most fundamental of the whole, I mean the Crystalline Form.

It is true, that the labours of Werner began ten years before the first attempts of Haüy, and, consequently, almost thirty years before the admirable developement which the doctrine of this great mineralogist has received; and Werner, on his part, has done so much for the progress of the science, that he may easily be excused for not having kept pace with all that his rivals have done; but the inexcusable thing is, that some of his disciples, from a mistaken zeal, and contrary to his uniform avowal, have shewn a desire to depress an order of truths, with which he had made them too little acquainted.

The reverse ought to have happened; the results of the two methods ought to be united and combined: far from being opposed to each other, they are the same in spirit, and are, in reality, but two branches of the same stem. Both of them, without pretending to deny that species do, in some respects, depend on composition; yet establish them without sufficiently consulting chemistry. They suppose for them, tacitly at least, a principle of individuality, which does not belong to the matter that composes them. Chemistry reproaches both of them with sometimes establishing Species gratuitously, and yet she is obliged to confess that both of them have frequently anticipated her, by indicating distinctions of substances, of which she has only been able to give an account by her analysis, after the fact had been ascertained.

The only difference is, that each of these two great mineralogists gives too exclusive a preponderance to those characters which he has most attentively studied.

Haüy, considering crystallisation as alone worthy to be set in competition with analysis, has resorted to methods which are more rigorous and more scientific, but from which a great many substances escape.

Werner, admitting subordinate properties to the same privilege, embraces more easily all kinds of minerals, but he has overlooked what is most profound and mysterious in their nature; and when, in the conflict of these two methods, he has endeavoured to set his subordinate properties in opposition not merely to analysis, but to crystallisation itself, he has almost always brought himself under the condemnation of that fundamental law, of which the properties he wished to employ are only corollaries.

Werner had thus devised a language for describing minerals;—he had arranged them;—he had assigned to each its distinctive characters, and had, in this manner, formed a Mineralogy, strictly so called, or what he named *Oryctognosy*, that is to say, the knowledge of fossils.

The history of their arrangement on the globe, or what he called *Geognosy*, that is the knowledge of the Earth, was the third point of view under which he considered them.

The Earth, in fact, is composed of mineral masses, and modern observers have satisfied themselves, that these masses are not thrown together at random.

Pallas, during his laborious travels to the extremity of Asia, had remarked that their superposition could be referred to fundamental laws.

Saussure and De Luc in traversing, in many directions, the most elevated mountain chains of Europe, had confirmed these joint observations.

Werner, without quitting his small province, has carried the knowledge of these laws to its utmost, and he has been able to read, in these laws, the history of all the revolutions of which they are the work.

Tracing every bed throughout its whole length, without permitting himself to be led astray by the interruptions which divide it, by the mountain crests and different elevations which rise above it, he has determined, in some sort, their different ages, and the age of all the accessory matters which are intermingled with the principal substances.

The different fluids by which the globe has been surrounded,—the changes of their composition,—the violent movements by which each change has been accompanied;—all of these have been found written, to his eye, in the monuments which they have left.

A universal and tranquil ocean deposites, in great masses, the primitive rocks,—those rocks which are distinctly crystallised, and in which silica is the first predominating ingredient. Granite forms the base on which all the others rest. To granite succeeds gneiss, which is only a granite beginning to be slaty. By degrees, argil predominates. Schists of different kinds appear; but in proportion as the purity of the precipitations is changed, the distinctness of the crystalline grain is diminished. Serpentines, porphyries, and traps succeed, in which this grain is still less distinct, although the siliceous nature of these rocks evinces the returning purity of the deposition. Intestine agitations in the fluid destroy a part of these primary deposites: new rocks are formed from their debris united by a cement. It is amidst these convulsions that living nature arises. Carbon, the first of these products, begins to shew itself. Lime, which had already been associated with the primitive rocks, becomes more and more abundant. Rich collections of sea salt, to be one day explored by man, fill immense cavities. The waters, again tranquillised, but having their contents changed, deposite beds less thick, and of greater variety, in which the remains of living bodies are successively accumulated, in an order not less fixed than that of the rocks which contain them. Finally, the last retreat of the waters diffuses over the land immense collections of alluvial matters, the first seats of vegetation, of cultivation, and of social life.

The metals, like the rocks, have had their epochs and their successions. The last of the primitive, and the first of the secondary rocks, have received them in abundance. They become rare in countries of later formation. Commonly they are found in particular situations, in those veins which seem to be rents produced in the great rocky masses, and which have been filled after their formation. But they are not all of equal age. Those which have been last formed are easily known, because their veins intersect those of the more ancient, and are not themselves intersected. Tin is the oldest of them all; silver and copper are the latest formed. Gold and iron, those two masters of the world, seem to have been deposited in the bowels of the earth, at all the different epochs of its formation; but iron appears at each epoch under different forms, and we can assign the age of its different mines.

The necessity of abridging obliges me thus to unite under one view, results which, we may easily imagine, could only have been obtained by many thousand observations. But Werner made all these observations with so much care; he combined them with such scrupulous correctness, that all those which have since been made by others, have confirmed his; and if we except his opinions respecting volcanic countries, of which I shall have another opportunity of speaking during this sitting, all the rest of his ideas have only met with a temporary opposition.

Such, then, is the explanation of the Geognosy, or of the position of minerals above one another, and when they are considered in their vertical situation. But there are other differences in their horizontal position, that is, as they are placed by the sides of each other, of which it is not less important to give an account. These form, therefore, a fourth point of view under which minerals may be considered, and which Werner designated by the name of Geographical Mineralogy.

Indeed, the latest formed rocks, or those which cover the others, are less elevated: they are pierced by the more ancient rocks, which form the lofty mountains. From this we conclude, that the fluid became lower in its level as its solid productions were multiplied. It divided itself into basins, of which the productions were different. The surface of different countries is different, there, and the more so, the more attentively their structure is considered.

But every mineral may be turned to some use; and on its greater or less abundance in particular places, on the greater or less facility with which it can be procured, depend frequently the prosperity of a people,—their progress in civilisation,—all the details, indeed, of their manners.

It is thus, that in Lombardy we see only houses of brick, though it is contiguous to Liguria, which is covered by palaces of marble. Its quarries of travertin made Rome the most beautiful city of the ancient world. Those of coarser limestone and of gypsum have made Paris one of the most agreeable of the modern world. But Michael Angelo and Bramant could not have built at Paris in the same style as at Rome, because they could not have found the same materials; and the same influence of local soil, extends itself to things of a very different nature.

Under the shelter of those limestone ridges which intersect Italy and Greece, which are of all heights,—which are ramified in all directions,—and which abound in springs;—in those charming valleys, rich in all the productions of living nature; Philosophy and the Arts first sprung to life. It is there that those minds have arisen, of which the human race has most reason to be proud; whilst the vast sandy deserts of Tartary and Africa have always been inhabited by fierce and wandering shepherds. And even in countries which have the same laws, and the same language, a practised traveller is able, from the manners of the people, from the appearance of their houses and of their clothes, to guess at the composition of the soil of each canton; in the same manner as, from this composition, the philosophical mineralogist conjectures what may be their manners, their degrees of comfort, and of instruction. Our granitic districts produce, upon all the arts of life, very different effects from our calcareous. The natives of the Limousin, or of Lower Brittany, are not lodged, they are not fed, we might even say, they do not think, like those of Champagne or of Normandy. Even the results of the conscription have been different, and different according to a fixed law in the different districts.

Geographical Mineralogy thus assumes a high importance, when we connect it with what Werner called Economical Mineralogy, or the history of the employment of minerals for the wants of man.

The comprehensive mind of this great Professor seized equally all these relations, and it was with an ever new delight, that his hearers listened to his exposition of so much of them as the plan of his public prelections embraced. But in his private conversations he traced their application a great deal farther. The history of nations, and that of their languages, was connected, in his apprehension, with that of minerals, and he never considered himself as departing from his principal object, when he gave himself up occasionally to those other inquiries. He traced the various tribes in their migrations, according to the declivities and directions of countries, and he thus connected their progress and their stations with the structure of the globe. He connected the different languages with families: he traced each family to a common source, originating always in the most elevated point of a mountain chain: from that point he considered every dialect as descending, dividing itself according to the direction of the valleys, becoming soft or harsh according as it became stationary in a level or in a mountainous district, separating itself in process of time from the neighbouring dialects, and becoming always so much the more distinct, as the natural obstacles to communication became more insurmountable.

He endeavoured even to trace the laws of the military art by those of geology; and, if he had been to be believed, all generals should have begun, by studying some time at Freyberg. In a word, he connected every thing with the object of his own passion; and as Tournefort, the illustrious botanist, had fancied that stones vegetated, Werner imagined that stones could speak. He imagined that he might confidently interrogate them respecting the whole history of the world.

Strangers who happened to be at Freyberg, and who expected only to converse with a mineralogist, were astonished at his continual discussions respecting tactics, politics, and medicine. They were sometimes tempted to treat these discourses as reveries of madness. Indeed, we may allow that there was something of exaggeration in generalizing so far the relations of one object: but we ought also to recollect how powerfully these ideas, so varied, and so inviting, presented always gracefully, and often with eloquence, must have warmed the imaginations of youth. At that age, when we naturally dislike exceptions, and when we pass so easily over difficulties, the disciples of Werner plunged into a career, which, as he shewed it to them, was so vast and so profound. A mineralogy purely mineralogical, would probably have disgusted many of them: but they gave themselves up with eagerness to this mineralogy, which seemed to put into their hands the key of Nature: and although, as the result of the analysis, there might only remain to them the foundation of the science, would they not still have had reason to bless the pleasant illusions by which they had been conducted to it?

Several individuals, who have since obtained the rank of great mineralogists in Germany, had only wished to hear him, that they might gain a summary idea of the Science of Minerals;

but having once listened to him, that science became the profession of their lives.

It is to this irresistible influence, that the scientific world has been indebted for those laborious authors, who have described, with so much care, the different modes under which minerals exist, and those indefatigable observers who have torn from the globe all its veils of mystery. Karsten and Wiedeman in the cabinet; Humboldt, Von Buch, Daubuisson, Hermann, and Freiesleben, on the summits of the Cordilleras, amidst the flames of Vesuvius and Ætna, in the desarts of Siberia, in the depths of the mines of Hungary, of Mexico, and Potosi, have been led on by the genius of their Master: they have attached the honour of their labours to him; and we may say of him, what had formerly been said with truth of Linnæus only, that every where Nature has been interrogated in his name.

Few teachers have enjoyed this pure and unreserved gratitude to the same degree; but, perhaps, no one ever better deserved it by his paternal feelings. He grudged nothing for the good of his scholars: his time, his exertions, were at their disposal. If he knew of any of them that were in occasional need, his purse was open to them. When his audience became so numerous that every one could not conveniently see what he exhibited, he divided the students, and repeated his lecture. His door was never shut to them: his meals were commonly taken with some of them in company, as if it had been his wish that not a moment should be lost to their improvement.

Such a master might safely devolve the care of his reputation upon his scholars; and they, accordingly, have been the instruments of diffusing it. Like Socrates, in this respect also, to whom he has been compared for so many other qualities, his ideas were almost solely known from the notes which had been taken during his prelections. Whether it was that he was satisfied with the irresistible influence which his oral communications gave him, or whether the vivacity of his imagination, could not endure the *ennui* of writing, it was with the utmost reluctance that he determined to publish one or two pamphlets, or to give some articles for the Journals. He talked as much as any one desired, and his conversation was always that of a man of genius, as well as that of a man of kind feelings. During whole hours, he could develope the boldest and best connected ideas; but it was impossibe to make him take up the pen. He had an antipathy for the very mechanical art of writing,—an antipathy, the very excess of which rendered it amusing. His letters were extremely few. The most tender friendship, the most profound esteem, could scarcely draw one from him; and to avoid reproaching himself with his want of politeness in this respect, he at last did not even open those that were addressed to him. A certain author, who wished to consult a great many philosophers respecting a voluminous work, had circulated his manuscript. The packet was amissing during this journey. After a thousand researches, it was disinterred at last from among a hundred others, in the possession of M. Werner. To crown all, I may notice, that he has never replied to the Academy, since it placed him in the list of its eight foreign associates, among whom all the greatest names that have illustrated Europe for a century are found: and, perhaps, he might never have known that he had obtained this honour, if he had not learned it from some almanack.

But we must pardon him, since, about the same time, it happened, that an express sent to him from Dresden, by his sister, waited two months at the inn, and at his expence, for a simple signature, on some pressing family business.

In Werner, this invincible antipathy seemed the more remarkable, that it affected him in that which, next to his studies, touched him the most, I mean, complaisance and etiquette. In every thing else, he observed the shades of social life with as much punctuality as he attended to the varieties of minerals. This disposition to formality, which was preserved for a longer time in Germany than any where else, and in Saxony for a longer time than in any other part of Germany, was especially preserved in him; apparently because, in his eyes, it was a kind of method: he deliberated respecting the arrangement of a dinner, with as much gravity as he did respecting that of his library or cabinet.

There was still, however, one point in which his regard to etiquette did not hold. Whatever might be the rank of any individual, if he handled his minerals awkwardly, the professor was put out of all temper. The least stain on their freshness, the least injury to their brilliancy, touched him to the quick, and he preserved a deep recollection of it. With his natural good humour, he would sometimes say, Such a one is a great minister, or an able general, but, he would add with a sigh, he never knew how to touch minerals.

These small eccentricities, at which he was the first to laugh, are in perfect agreement with all the qualities of the most celebrated genius, and the most amiable disposition. In this case, they never lessened the tender veneration entertained for him by those young persons who were always happy to be instructed, and warmed by his words and by his attentions. His scholars studied his eccentricities only to accommodate themselves to them, being anxious to manifest their attachment, even by attending to his foibles.

But the public and posterity will have reason to lament those peculiarities, because, by them, they have been deprived of works of great value, and which no other person, for a long time, will be able to execute so well. It is said, that his great work on Mineralogy had begun to be printed, and that the first sheet had been composed, but that he could not endure the fatigue of correcting the proofs.

His life was, therefore, entirely passed either in the elevated regions of contemplation, or in philosophical and friendly conversation,—ignorant of all foreign events, without reading even the literary journals, without being at the trouble to inform himself whether envy was not sometimes busy with his fame. He might still have lived for many years; for of all the *methods* which he had studied, that of taking care of his own health, was not one of those which occupied him the least. Among his little whims, his care never to be between two different streams of air, was one of the most remarkable. But of all his precautions, the wisest, without doubt, was the calm of a peaceful mind, which did not even wish to be informed of any thing that could excite within it any feelings of ill-will.

The misfortunes of Saxony were alone able to deceive his foresight, and to destroy the peace which it had given him. He tenderly loved that country with which he had identified himself in a thousand ways; no offer had been able to make him quit it. He was devoted to a prince who protects the sciences, because he has profoundly studied them, and whom forty years of the highest prudence, and of the most tender devotion to his people, have not been able to preserve from so many calamities. His courage could not withstand the sight of the sufferings of his master and of his country, and the distresses of his heart produced in him a complication of diseases, to which no care could afford relief. He died in the arms of his sister, on the 30th of June 1817, at Dresden, whither he had gone in the hope of some mitigation of his sufferings.

It seems as if fortune had conducted him to that capital, that he might there receive more solemn honours. The most illustrious personages of the kingdom assisted at his obsequies. M. Boettiger, a distinguished philosopher, publicly pronounced his funeral oration. The most celebrated academies of Germany have paid him the same tribute which we are paying to him this day, and which will be decreed to him, under one form or another, in every country of the world in which any of the branches of the sciences of the Earth is cultivated.

Art. II.—*Account of the Recent Chemical Researches of M. Berzelius and his Pupils.* In a Letter to Dr Brewster from a Correspondent in Stockholm.

1. *Account of Berzelius's Analysis of the Ferruginous and Sulphuretted Prussiates.*

M. Berzelius has lately been engaged in examining the ferruginous and the sulphuretted Prussiates, the composition of which has for some time past become so interesting, from the different, and in general improbable, results, which several chemists, such as Porret, Thomson, Robiquet, Von Grotthus, and Doebereiner, have deduced from their experiments. From his analysis of the ferruginous Prussiates, M. Berzelius draws the conclusion, that they are true double prussiates, with two bases, of which the protoxide of iron is always one; whilst the other base, which may vary, contains constantly as much oxygen as the protoxide of iron. The ferruginous prussiates of potash, barytes, and lime, have the property of efflorescing in heat, as well as in a vacuum at the ordinary temperature of the atmosphere. They then lose not only their water of crystallization, but also that which is produced by the combination of the hydrocyanic or prussic acid with the oxygen of the two bases; and there remains a double cyanuret, composed of one atom of cyanuret of iron, with two atoms of cyanuret of the other metal. The same thing also takes place with the ferruginous prussiates of lead and silver.

When these cyanurets are burned with the oxide of copper in a suitable apparatus, they give no water. The double cyanuret of iron and lead yields carbonic gas and azotic gas in the proportion of 2 to 1; but those of potassium and barium yield them in the proportion of 3 to 2, because the base retains *one-fourth* of the carbonic acid, forming a species of double salt of carbonate and cuprate of potash or barytes. The prussiate of iron and ammonia is not capable of being reduced to a double cyanuret. When distilled, it yields prussiate of ammonia, and a little water formed by the conversion of prussiate of iron into a cyanuret. The cyanuret afterwards decomposes and gives out azotic gas, leaving as a residue a carburet of iron, composed of 4 atoms of carbon and 1 atom of iron. The carburet presents a very remarkable phenomenon: when heated to redness in the retort, it takes fire, and appears to burn as in oxygen gas, though the gas which surrounds it is only azotic gas, and though it experiences no alteration. The flame lasts only for an instant: It is analogous to that which is exhibited with oxide of iron, and that of chrome, zircon, &c. when they are heated to redness, after having taken away from them their water of combination. This same phenomenon is observed in the distillation of several of the ferruginated prussiates, particularly in that of Prussian blue. The acid substance called by Mr Porret the Ferruretted Chyazic Acid, is, according to M. Berzelius, a prussiate acid of the protoxide of iron, where the base is combined with three times as much acid as in the neutral prussiate.

M. Berzelius prepares this acid salt in decomposing the prussiate of iron and lead under water, by means of a current of sulphuretted hydrogen gas. The hepatic liquid is put in contact with a new portion of prussiate, in order to remove the sulphuretted hydrogen in excess; it is then filtered, and evaporated *in vacuo.*

M. Berzelius compares the idea of making it a particular acid to that of considering cream of tartar as an acid of sel seignette or of tartar emetic.

Most of the ferruginated prussiates are capable of being dissolved in concentrated sulphuric acid, without experiencing any decomposition. In allowing the acid to attract the humidity of the air, the new combination deposits itself often in the form of crystals. The combinations are acid salts, with two bases and with two acids. They are not formed of cyanurets and sulphuric acid, because the prussiate of iron, with excess of acid, (Ferruretted Chyazic Acid), combines also without alteration with concentrated sulphuric acid.

M. Berzelius tried in vain to produce the new gas which Dr Thomson pretends to have discovered, in treating the ferruginated prussiate of potash by concentrated sulphuric acid.

The double cyanuret of iron and potassium, mixed with sulphur, and heated, combines with the last at a temperature which exceeds a little that of melted sulphur. Hence, there results a new combination, which M. Berzelius calls a *Sulpho-cyanuret of Potassium, mixed with a Sulpho-cyanuret of Iron.* The latter decomposes itself in part, in proportion as the temperature rises, and gives birth to sulphuret of iron, which remains near the sulpho-cyanuret of potassium, and to sulphuret of carbon, an azotic gas, which escape together.

The sulpho-cyanuret of potassium is soluble in water and in alcohol, from which it is obtained by crystallization: the crystals contain no water, that is to say, they are not converted into sulphuretted hydro-cyanite of potash. Each atom of cyanuret of potassium combines with 4 atoms of sulphur, from which it follows, that the composition of the sulpho-cyanuret may be expressed after the method of M. Berzelius, by $K + 2\dot{N}C^2S^2$. That is to say, that in the case where the elements are oxidated, there would result either neutral nitrate of potash, or bicarbonate, or bisulphate of potash.

M. Berzelius considers the sulpho-cyanurets as containing a compound electro-negative particular body, which he calls Sulphuret of Cyanogen, and which is composed of equal volumes (or atoms) of azote, carbon, and sulphur. The sulphuretted hydro-cyanic acid which results from the combination of sulphuret of cyanogen with hydrogen, is composed also of equal volumes of azote, of hydrogen, of carbon, and of sulphur. M. Berzelius admits, that the phenomena presented by the cyanurets and the sulpho-cyanurets, can only be explained by a theory analogous to that which Sir Humphry Davy and M. Gay Lussac have applied to the muriates, with which M. Berzelius finds that the sulpho-cyanurets have a striking analogy. This analogy allows us to presume, also, on an analogy between chlorine or the oxymuriatic gas and the sulphuret of cyanogen. M. Berzelius has attempted to obtain this last substance in an insulated state, for the purpose of studying its properties; but he has hitherto tried it in vain.

Selenium gives with the cyanuret of iron and of potassium phenomena analogous to those produced by sulphur. The selenio-cyanuret of potassium resembles perfectly the sulpho-cyanuret; but if we mix it with any acid, the Selenium is immediately precipitated in red flowers.

Tellurium allows itself to mix with the double cyanuret of iron and potassium, if they are melted together; but water separates them; the cyanuret dissolves without alteration, and the Tellurium remains in the form of a metallic powder.

2. *Account of M. Mitscherlich's Experiments on the Forms of artificially crystallised Salts.*

M. Mitscherlich, a young chemist from Berlin, has been much occupied in determining the form of artificially crystallised salts. In the course of this inquiry, he has arrived at many results of very high importance respecting the relation which exists between the composition and the form of these crystals. Having studied during the last year under M. Berzelius, he has repeated before him a great number of his experiments, which were found to be perfectly exact. M. Mitscherlich has discovered that several substances, simple as well as compound, may replace one another in compound bodies, without any change of form taking place in the latter, provided that the other constituent principles remain the same, and in the same proportions. He has found for example, that *Phosphorus* and *Arsenic* replace one another in such a manner, that the *Phos-*

phates crystallise in exactly the same manner as the *Arseniates* of the same bases, when they are at the same point of saturation, and contain the same number of atoms of water of crystallisation, which is generally the case. The protoxides of the five following metals, viz. *iron*, *zinc*, *cobalt*, *nickel*, and *manganese*; the *deutoxide of copper*, and also *lime* and *magnesia*, replace one another mutually, provided always, that in the combinations which are examined the number of atoms of water be the same. *Alumine*, the *deutoxide of iron*, and also that of *manganese*, may also be substituted for one another, without any change of form. *Barytes*, *strontian*, and the *oxide of lead*, are in the same predicament, and also *chlorine* and *iodine*, and *sulphur* and *selenium*, &c. To these different groups, M. Mitscherlich has given the name of *Isomorphous Bodies*.

This ingenious chemist is at present occupied in determining how many of such *isomorphous groups* exist among simple bodies, and among their different degrees of oxidation; and also in determining to what isomorphous group each of them belongs.

The discoveries of M. Mitscherlich throw great light upon mineralogy, and will give a key to an explanation of the contradictions of chemical analysis, and of the geometrical measurements of crystals; because, in a mineral species whose form has been determined with the greatest certainty, one or more elements may vary, provided that they belong to the same isomorphous class, and that the other elements remain the same. Hence, it is for this reason that lime, magnesia, the protoxide of iron, and the protoxide of manganese, are substituted for one another in the Amphiboles and the Pyroxenes.

M. Mitscherlich has found also, that when several combinations, isomorphous salts, for example, are mixed in the same liquid, and when this liquid is afterwards evaporated, the isomorphous salts crystallise together, forming a part of the same crystal, and their relative proportion is then determined only by the relative quantity of each which the liquid has had to abandon at the moment of crystallisation. The crystal, in short, is, as it were, built of isomorphous molecules, without any chemical affinity having a share in it, and without our being able to perceive fixed and determinate proportions. This experiment is one of high importance, as it explains the objections which the results of the analyses of certain minerals form to the Theory of Definite Proportions.

3. *Account of the Analyses of the Pyroxenes and Amphiboles, by MM. Rose, Nordenskold, and Bohnsdorff.*

MM. Rose, Nordenskold, and Bohnsdorff, three young chemists, who are at present working in the laboratory of M. Berzelius, have undertaken to verify by analyses the application of the ideas of M. Mitscherlich to mineralogy. With this view, they have begun a series of analyses of the *Pyroxenes* and the *Amphiboles.* It results from this inquiry, which is still far from being finished, that the mineral called Pyroxene, when it is uncoloured, is a double bisilicate of lime and magnesia, containing an atom of each; but that when it is coloured, it then consists of a mixture of bisilicate of lime, of bisilicate of magnesia, of bisilicate of the protoxide of iron, and, less frequently, of the bisilicate of the protoxide of manganese; without these bases being combined in proportions conformable to the theory of definite proportions. The only thing constant is, that all the bases belong to the same isomorphous class, and that they are all in the form of bisilicates.

One of these pyroxenes, analysed by Mr Rose, was found to be a double bisilicate of lime, and of protoxide of iron, containing an atom of each of these bases. This pyroxene is the one which has been called *Hedenbergite,* and which has been considered, after the analysis of M. Hedenberg, as a bisilicate of the protoxide of iron. Another has been found to be composed almost entirely of the bisilicate of the protoxide of manganese, with a very little of the bisilicate of lime.

4. *Account of M. Rose's Analyses of several Species of Mica, containing Fluoric Acid.*

M. Rose has lately analysed several species of mica, in which he has discovered *Fluoric Acid* in considerable quantity. The Mica of granites contains more of it than that of primitive carbonate of lime, which contains only traces of it. We may easily discover if any species of Mica is more or less rich in fluoric acid, by exposing it to the fire. That which contains about a per cent. of it, loses its lustre and becomes matted, while that which contains only traces of it assumes a metallic lustre. The following are the results of M. Rose's analyses of three kinds of mica.

1. *Mica of Broddbo near Fahlun.*

Silex	46.10
Oxide of Iron	8.65
Alumine	31.16
Oxide of Manganese	1.40
Potash	8.39
Fluoric Acid	1.12
Water	0.87
	98.13

2. *Mica from Kimito in Finland.*

Silex	46.358
Oxide of Iron	4.533
Alumine	36.800
Oxide of Manganese	0.02
Potash	9.22
Fluoric Acid	0.76
Water	1.04
	98.713

3. *Mica from the Iron Mine of Uto.*

Silex	47.5
Oxide of Iron	3.2
Alumine	37.2
Oxide of Manganese	0.9
Potash	9.6
Fluoric Acid	0.56
Water	1.39
	100.35

STOCKHOLM,
Sept. 21. 1820.

Art. III.—*On Isothermal Lines, and the Distribution of Heat Over the Globe.* By Baron Alexander de Humboldt. (Continued from Vol. III. p. 274.)

After what has already been stated respecting the limits between which the annual heat divides itself on the same isothermal curve, it will be seen how far we are authorised to say, that the *Coffee-tree*, the *Olive*, and the *Vine*, in order to be productive, require mean temperatures of 64°.4; 60°.8, and 53°.6 Fahr. These expressions are true only of the same system of climate, for example, of the part of the Old World which stretches to the west of the meridian of Mont Blanc; because in a zone of small extent in longitude, while we fix the annual temperatures, we determine also the nature of the summers and the winters. It is known likewise, that the olive, the vine, the varieties of grain, and the fruit-trees, require entirely different constitutions of the atmosphere. Among our cultivated plants, some, slightly sensible of the rigours of winter, require very warm but not long summers; others require summers rather long than warm; while others, again, indifferent to the temperature of summer, cannot resist the great colds of winter. Hence, it follows, that, in reference to the culture of useful vegetables, we must discuss three things for each climate,—the mean temperature of the entire summer,—that of the warmest month,—and that of the coldest month. I have published the numerical results of this discussion in my *Prolegomena de Distributione Geographica Plantarum, secundum Cœli Temperiem*; and I shall confine myself at present to the limits of culture of the olive and the vine. The olive is cultivated in our continent between the parallels of 36° and 44°, wherever the annual temperature is from 62°.6 to 58°.1, where the mean temperature of the coldest month is not below from 41°.0 to 42°.8, and that of the whole summer from 71°.6 to 73°.4 *. In the New World, the division of heat between the seasons is such, that on the isothermal line of 58°.1, the coldest month is

* In cases like the present, we have not used the round numbers of Fahrenheit, as is done in the original with the Centigrade scale, but have given the real value of the degrees used by the author, that his exact numbers may always be ascertained.—Ed.

35°.6, and that the thermometer sometimes sinks there even during several days from 14° to 10°.4. The region of potable wines extends in Europe between the isothermal lines of 62°.6 and 50°, which correspond to the latitudes of 36° and 48°. The cultivation of the vine extends, though with less advantage, even to countries whose annual temperature descends to 48°.2 and to 47°.48; that of winter to 33°.8, and that of summer to 66°.2 and 68°. These meteorological conditions are fulfilled in Europe as far as the parallel of 50°, and a little beyond it. In America, they do not exist farther north than 40°. They have begun, indeed, some years ago to make a very good red wine to the west of Washington, beyond the first chain of mountains, in the valleys which do not extend beyond 38° 54′ of Lat. On the Continent of Western Europe, the winters, whose mean temperature is 32°, do not commence till on the isothermal lines of 48°.2 and 50°, in from 51° to 52° of latitude; while in America, we find them already on the isothermal lines of from 51°.8 to 53°.6, under from 40° to 41° of latitude.

If, instead of considering the natural inflexions of the isothermal lines, that is to say, those that propagate themselves progressively at great intervals of longitude, we direct our attention to their partial inflexions, or to *particular systems of climates* occupying a small extent of country, we shall still find the same variations in the division of the annual heat between the different seasons. These partial inflexions are most remarkable,

1*st*, In the Crimea, where the climate of Odessa is contrasted with that of the S.W. shores of the Chersonesus, sheltered by mountains, and fit for the cultivation of the olive and the orange tree.

2*dly*, Along the Gulf of Genoa, from Toulon and the Hieres Isles to Nice and Bordighera, (*Annales du Museum*, tom. xi. p. 219.), where the small maritime palm-tree, *Chamærops*, grows wild, and where the date-tree is cultivated on a large scale, not to obtain its fruit, but the palms or etiolated leaves.

3*dly*, In England, on the coast of Devonshire, where the port of Salcombe has, on account of its temperate climate, been called the Montpellier of the North, and where (in South Hams) the Myrtle, the *Camellia Japonica*, the *Fuchsia coccinea*, and the

Buddleia globosa *, pass the winter in the open ground, and without shelter.

4*thly*, In France, on the western coasts of Normandy and Brittany. In the Department of Finisterre, the arbutus, the pomegranate-tree, the *Yucca gloriosa* and *aloifolia*, the *Erica Mediterranea*, the *Hortensia*, the *Fuchsia*, the *Dahlia*, resist in open ground the inclemency of a winter which lasts scarcely fifteen or twenty days, and which succeeds to a summer by no means warm. During this short winter, the thermometer sometimes falls to 17°.6. The sap ascends in the trees from the month of February; but it often freezes even in the middle of May. The *Lavatera arborea* is found wild in the isle of Glenans, and opposite to this island, on the continent, the *Astragalus Bajonensis*, and the *Laurus nobilis* †.

From observations made in Brittany for twelve years, at St Malo, at Nantes, and at Brest, the mean temperature of the peninsula appears to be above 56°.3. In the interior of France, where the land is not much elevated above the sea, we must descend 3° of latitude in order to find an annual temperature like this.

It is known from the researches of Arthur Young ‡, that in spite of the great rise of the two isothermal lines of 53°.6 and 55°.4 on the western coast of France, the lines of culture (those of the olive, and of the maize and vine,) have a direction ‖ quite opposite, from S.W. to N.E. This phenomenon has been ascribed §, with reason, to the low temperature of the summers

* Knight, *Trans. Hort. Soc.* vol. i. p. 32. In 1774, an Agave flowered at Salcombe, after having lived twenty-eight years without being covered in winter. On the coast of England, the winters are so mild, that orange trees are seen on espaliers, which are sheltered, as at Rome, only by means of a matting.—H.

† Bonnemaison, *Geogr. Botan. du Depart. du Finisterre*, (*Journal de Botan.* tom. iii. p. 118.)

‡ *Travels in France*, vol. ii. p. 91.

‖ The line which limits the cultivation of the vine, extends from the embouchure of the Loire and of the Vilaine, by Pontoise, to the confluence of the Rhine and the Moselle. The line of the olive trees commences to the west of Narbonne, passes between Orange and Montelimart, and carries itself to the N.E. in the direction of the Great St Bernard.—H.

§ Decandolle, *Flor. Franç.* 3d edit. tom. ii. pl. viii. xi. Lequinio, *Voy. dans le Jura*, tom. ii. p. 84.—91.

along the coast; but no attempt has been made to reduce to numerical expressions the ratios between the seasons in the interior and on the coast. In order to do this, I have chosen *eight* places, some of which lie under the same geographic parallels, and others in the prolongation of the same isothermal line. I have compared the temperatures of winter, of summer, and of the warmest months; for a summer of uniform heat excites less the force of vegetation, than a great heat, preceded by a cold season. The terms of comparison have been along the Atlantic; the coasts of Brittany, (from St Malo and St Brieux to Vannes and Nantes); the sands of Olonne; the Isle of Oleron; the embouchure of the Garonne and Dax, in the department of the Landes; and in the interior, corresponding to the same parallel, Chalons sur Marne, Paris, Chartres, Troyes, Poitiers, and Montauban. Farther south, from 44½° of Lat. the comparisons become incorrect, because France, locked between the Ocean and the Mediterranean, presents, along this last basin, in the fine region of the olives, a system of climate of a particular kind, and very different from that of the western coast.

Places in the Interior.	Latitude.	Mean Temperature			
		Of the Year.	Of Winter.	Of Summer.	Of the Warmest Month.
		Fahr.	Fahr.	Fahr.	Fahr.
Chalons sur Marne, -	48°.57	50°.5	36°.1	66°.6	67°.5
Paris, - - -	48.50	51.1	38.7	65.3	67.5
Chartres, - -	48.26	50.7	37.0	64.6	65.7
Troyes, - -	48.18	52.2	38.3	67.3	68.4
Chinon, - -	47.26	53.4	38.7	69.1	70.2
Poitiers, - -	46.39	54.3	39.7	67.1	69.3
Vienne, - -	45.31	55.0	38.7	71.6	73.4
Montauban, -	44.01	55.6	42.6	69.3	71.4
Places on the Coast.					
St Malo, - -	48°.39′	55°.5	42°.4	66°.9	67°.5
St Brieux, - -	48.31	52.3	41.7	64.4	67.1
Vannes, - -	47.39	51.8	39.7	64.4	65.8
Nantes, - -	47.13	54.7	40.5	68.5	70.5
La Rochelle, - -	46.14	53.1	40.3	66.6	67.1
Oleron, - -	45.56	58.1	44.6	68.5	72.1
Bourdeaux, - -	44.50	56.5	42.1	70.9	71.4
Dax, - - -	43.52	54.1	44.4	67.3	68.9

These results are deduced from 127,000 observations, made with sixteen thermometers, of, no doubt, unequal accuracy. In supposing, on the theory of probabilities, that in such a number of observations, the errors, in the construction and exposure of the instruments, and in the hours of observation, will, in a great measure, destroy one another, we may determine, by interpolation, either under the same parallel, or upon the same isothermal line, the *mean winters* and *summers* of the interior and of the coast of France. This comparison gives,—

			Mean Winter.	Mean Summer.	Annual Temp.
I. Isothermal Lines of	52°.7	Coast,	40°.6	65°.1	
		Interior,	38.5	68.0	
	54°.7	Coast,	41.4	67.3	
		Interior,	39.2	68.4	
I. Parallels of	47° to 49°	Coast,	41°.0	66°.7	53°.0
		Interior,	37.8	66.6	51.6
	45° to 46°	Coast,	42.3	67.8	55.8
		Interior,	39.2	69.3	54.7

As the isothermal lines rise again towards the western coasts of France; that is to say, as the mean temperature of the year becomes there greater than under the same latitude in the interior of the country, we ought to expect, that in advancing from east to west under the same parallel, the heat of the summers would not diminish. But the rising, again, of the isothermal lines, and the proximity of the sea, tend equally to increase the mildness of the winters; and each of these two causes acts in an opposite manner upon the summers. If the division of the heat between these seasons was equal in Brittany and in Orleannois, in the *climate of the coast*, and the *continental climates*, we ought to find the winters and summers warmer in the same latitude along the coast. In following the same isothermal lines, we readily observe, in the preceding table, that the winters are colder in the interior of the country, and the summers more temperate upon the coasts. These observations confirm in general the popular opinion respecting the climate of coasts; but in recollecting the cultivation and the developement of vegetation on the coasts and in the interior of France, we should expect differences of temperature still more considerable. It is surprising that these differences between the winter and the summer should not exceed 1°.8, or nearly a quarter of the difference between the mean temperature of the winters or the summers of Montpellier and Paris. In speaking of the limits of the cultivation of plants upon mountains, I shall explain the true cause of this apparent contradiction. In the mean time, it may be sufficient to remark, that our meteorological instruments do not indicate the quantity of heat, which, in a clear and dry state of the air, the direct light produces in the more or less coloured parenchyma of the leaves and fruits. In the same mean temperature of the atmosphere, the developement of vegetation is retarded or accelerated, according as the sky is foggy or serene, and according as the surface of the earth receives only a diffuse light, during entire weeks, or is struck by the direct rays of the sun. On the state of the atmosphere, and the degree of the extinction of light, depend, in a great measure, those phenomena of vegetable life, the contrasts of which surprise us in islands, in the interior of continents, in plains, and on the summit of mountains. If we neglect these photometrical considerations, and do not appreciate the production of heat in the interior of bodies, and the effect of nocturnal radiation in a clear or a cloudy sky, we shall have some difficulty in discovering, from the numerical ratios of the observed summer and winter temperatures of Paris and London, the causes of the striking difference which appears in France and England in the culture of the vine, the peach, and other fruit-trees *.

When we study the organic life of plants and animals, we must examine all the stimuli or external agents which modify their vital actions. The ratios of the mean temperatures of the months are not sufficient to characterise the climate. Its influence combines the simultaneous action of all physical causes; and it depends on heat, humidity, light, the electrical tension of vapours, and the variable pressure of the atmosphere. It is the last cause which, on the tops of mountains, modifies the perspiration of plants, and even increases the exhaling organs. In making known the empirical laws of the distribution of heat

* Young's *Travels in France*, vol. ii. p. 195.

over the globe, as deducible from the thermometrical variations of the air, we are far from considering these laws as the only ones necessary to resolve all the problems of climate. Most of the phenomena of nature present two distinct parts, one which may be subjected to exact calculation, and another which cannot be reached but through the medium of induction and analogy.

Having considered the division of heat between winter and summer on the same isothermal line, we shall now point out the numerical ratios between the mean temperature of spring and winter, and between that of the whole year and the warmest month. From the parallel of Rome to that of Stockholm, and consequently between the isothermal lines of 60°.8 and 41°, the difference of the months of April and May is everywhere 10°.8 or 12°.6, and all the successive months are those which present the most rapid increase of temperature. But, as in northern countries, in Sweden, for example, the month of April is only 37°.4, the 10°.8 or 12°.6 which the month of May adds *, necessarily produces there a much greater effect on the developement of vegetation than in the south of Europe, where the mean temperature of April is from 53°.6 to 55°.4. It is from an analogous cause, that in passing from the shade to the sun, either in our climates in winter, or between the tropics on the back of the Cordilleras, we are more affected by the difference of temperature than in summer and in the plains, though in both cases the thermometrical difference is the same, for example from 5°.4 to 7°.2. Near the polar circle, the increase of the vernal heat is not only more sensible, but it extends equally to the month of June. At Drontheim, the temperatures of April and May, like those of May and June, differ not 10°.8 or 12°.6, but 14°.4 or 16°.2.

In distinguishing upon the same isothermal line the places which approach its concave or convex summits, in the same sys-

* In calculating for Europe, from 46° to 48° of Lat. for ten years the mean temperatures of every ten days, we find, that the decades which succeed one another, differ near the summits of the annual curve only 1°.44, while the differences rise in autumn from 3°.6 to 5°.4, and in spring from 5°.4 to 7°.2.—H.

tem of climates in the northern and southern regions, we shall find,

1*st*, That the increase of the vernal temperature is great, (from 14°.4 or 16°.2, in the space of a month), and equally prolonged, wherever the division of the annual heat between the seasons is very unequal, as in the north of Europe, and in the temperate part of the United States.

2*dly*, That the vernal increase is great, (at least above 9° or 10°.8), but little prolonged, in the temperate part of Europe.

3*dly*, That the increase of the vernal temperature is small, (scarcely 7°.2), and equally prolonged, wherever there is an insular climate.

4*thly*, That in every system of climates, in the zones contained between the same meridians, the vernal increase is smaller, and less equally prolonged, in low than in high latitudes.

The isothermal zone from 53°.6 to 55°.4, may serve as an example for confirming these different modifications of spring. In Eastern Asia, near the concave summit, the differences of temperature between the four months of March, April, May and June, are very great, and very equal, (15°.7, 13°.3, and 13°.9). In advancing westward towards Europe, the isothermal line rises again, and in the interior of the country, near the convex summit, the increase is still greater, but little prolonged; that is to say, that of the four months which succeed one another, there are only two whose difference rises to 13°: they are 9°.4; 13°.3; 4°.1. Farther west, on the coasts, the differences become small and equal, viz. 3°.6; 6°.5; 5°.6. In crossing the Atlantic, we approach the western concave summit of the isothermal line of 53°.6. The increase of vernal temperature shews itself anew, and almost as great, and as much prolonged, as near the Arctic concave summit. The differences of the four months are 10°.4; 13°.9; and 10°.8. In the curve of annual temperature, the spring and autumn mark the transitions from the *minimum* and the *maximum*. The increments are naturally slower near the summits than in the intermediate part of the curve. Here they are greater, and of longer continuance, in proportion to the difference of the extreme ordinates. The autumnal decrease of temperature is less rapid than the vernal increase, because the surface of the earth acquires the maximum of heat slower than the atmosphere, and because, in spite of the serenity of the air which prevails in autumn, the earth loses slowly, by radiation, the heat which it has acquired. The following Table will shew how uniform the laws are which I have just established.

Names of Places.	Latitude.	March.	April.	May.	June.	Differences of Temperature of the Four Months.			Mean Temp. of the Year.
I. Group,—*Concave Summits in America.*									
Natchez,	31° 28′	57°.9	66°.2	72°.7	79°.5	8°.3	6°.1	7°.2	64°.8
Williamsburg,	37 18	46.4	61.2	66.6	77.7	14.8	5.4	11.2	58.1
Cincinnati,	39 0	43.7	57.4	61.2	70.9	13.7	3.6	9.7	53.8
Philadelphia,	39 56	44.1	53.6	62.1	72.3	9.5	8.5	10.3	53.6
New York,	40 40	38.7	49.1	65.8	80.2	10.4	16.7	14.4	53.9
Cambridge,	42 25	34.5	45.5	56.8	70.2	11.0	11.3	13.3	50.4
Quebec,	46 47	23.0	39.6	54.7	63.9	16.6	15.1	41.2	41.7
Nain,	57 0	6.8	27.5	37.0	43.3	20.7	9.5	8.1	26.4
II. Group,—*Convex Summits in Europe.*									
1. *Continental Climate:*									
Rome,	41 53	50.4	55.4	66.9	72.3	5.0	11.5	5.4	60.4
Milan,	45 28	47.8	51.1	65.1	70.5	7.7	9.5	5.4	55.8
Geneva,	46 12	39.6	45.5	58.1	62.2	6.1	12.4	4.1	49.3
Buda,	47 29	38.3	49.1	64.8	68.4	10.8	15.7	3.6	51.1
Paris,	48 50	42.3	48.2	60.1	64.4	8.5	11.9	4.3	51.1
Gottingen,	51 32	34.2	44.2	57.7	62.2	10.1	13.5	4.5	46.9
Upsal,	59 51	29.5	39.7	48.7	57.9	10.3	9.0	9.2	41.9
Petersburg,	59 56	27.5	37.0	50.2	59.4	9.5	13.1	9.2	38.8
Umeo,	63 50	23.0	34.2	43.7	55.0	11.2	9.5	11.3	33.3
Uleo,	65 0	14.0	26.2	41.0	55.0	12.2	14.8	14.0	33.1
Enontekies,	68 30	11.5	26.6	36.5	49.5	15.1	9.9	13.0	27.0
2. *Climate of the Coast:*									
Nantes,	47 13	50.0	53.6	60.1	65.7	3.6	6.5	5.6	54.7
London,	51 30	44.2	49.8	56.5	63.1	5.6	6.7	6.7	51.6
Dublin,	53 21	41.9	45.3	51.8	55.6	3.4	6.5	4.0	48.4
Edinburgh,	55 57	41.4	47.3	50.5	57.2	5.8	3.2	6.7	47.8
North Cape,	71 0	25.0	30.0	34.0	40.1	5.2	4.0	6.1	32.0
III. Group,—*Concave Summit of Asia.*									
Pekin,	39 54	41.4	57.0	70.3	84.2	15.7	13.3	13.9	54.9

In all places whose mean temperature is below 62°.6, the revival of nature takes place in spring, in that month whose mean temperature reaches 42°.8 or 46°.4. When a month rises to,

41°.9, the Peach-tree *(Amygdalus Persica)* flowers.
46°.8, the Plum-tree *(Prunus domestica)* flowers.
51°.8, the Birch-tree * *(Betula alba)* pushes out its leaves.

At Rome, it is the month of March, at Paris the beginning of May, and at Upsal the beginning of June, that reaches the mean temperature of 51°.8. Near the Hospice of St Gothard, the birch cannot vegetate, as the warmest month of the year there scarcely reaches 46°.5. Barley, in order to be cultivated advantageously, requires †, during ninety days, a mean temperature of from 47°.3 to 48°.2. By adding the mean temperatures of the months above 51°.8, that is, the temperatures of those in which trees vegetate that lose their foliage, we shall have a sufficiently exact mean of the strength and continuance of vegetation. As we advance towards the north, vegetable life is confined to a shorter interval. In the south of France, there are 270 days of the year in which the mean temperature exceeds 51°.8; that is to say, the temperature which the birch requires to put forth its first leaves. At St Petersburgh, the number of these days is only 120. These two *cycles of vegetation*, so unequal, have a mean temperature which does not differ more than 5°.4; and even this want of heat is compensated by the effects of the direct light, which acts on the parenchyma of plants in proportion to the length of the days. If we compare, in the following *Table*, Eastern Asia, Europe, and America, we shall discover, by the increase of heat during the cycle of vegetation, the points where the isothermal lines have their concave summits. The exact knowledge of these cycles, will throw more light on the problem of Agricultural Geography, than the examination of the single temperatures of summer.

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* Cotte, *Meteorologie*, p. 448.—Wahlenberg, *Flor. Lap.* Pl. 51.

† Playfair, *Edin. Trans.* vol. v. p. 202.—Wahlenberg in Gilbert's *Annalen*, tom. xli. p. 282.

Lines of Equal Heat.	Names of Places.	Latitude.	Mean Temp. of the Year.	Sum of the Mean Temp. of the Months that reach 51°.8.	Number of those Months.	Mean Temperat. of the days which reach 51°.8.	Mean Temperature of the warmest Months.	Observations.
Isothermal Line of 59°.0,	Rome,	41° 53′	60°.4	585°	9	64°.8	77°.0	Basin of the Mediterranean.
	Nismes,	43 50	60.3	593	9	65.8	78.3	*Idem.*
Isothermal Line of 53°.6,	Pekin,	39 54	54.9	499	7	71.2	84.2	Eastern concave summit.
	Poitiers,	46 34	54.3	426	7	60.8	69.3	Convex summit.
	Nantes,	47 13	54.7	438	7	62.6	69.8	*Idem*, coasts.
	St Malo,	48 39	53.8	431	7	61.5	68.4	*Idem.*
	Philadelphia,	39 56	53.4	463	7	66.2	77.0	Western concave summit.
	Cincinnati,	39 6	53.8	458	7	65.5	74.3	*Idem.*
Isothermal Line of 50°.0,	London,	51 30	51.8	364	6	60.6	66.6	Insular climate.
	Paris,	48 50	51.1	381	6	63.5	69.8	Near the coasts.
	Buda,	47 29	51.1	323	5	64.6	72.0	Interior.
Isothermal Line of 48°.2,	Geneva,	46 12	49.3	311	5	62.2	66.6	Interior.
	Dublin,	53 21	48.7	282	5	56.5	60.8	Climate of the coasts.
	Edinburgh,	55 57	47.8	279	5	55.8	59.4	*Idem*,
Isothermal Line of 41°.0,	Upsal,	59 51	41.9	229	4	57.2	61.9	Convex summit.
	Quebec,	46 47	41.7	318	5	63.7	73.4	Western concave summit.
Isothermal Line of 32°.0,	Petersburgh,	59 56	38.8	236	4	59.0	65.7	East of Europe.
	Umeo,	53 50	33.3	118	2	59.0	62.6	E. Coast of Gulf of Bothnia.
	North Cape,	71 0	32.0	0	0	0	46.6	Interior climate.
	Enontekies,	68 30	27.0	116	2	58.1	59.5	Continental climate.

In the system of European climates, from Rome to Upsal, between the isothermal lines of 59° and 41°, the warmest month adds from 16°.2 to 18° to the mean temperature of the year. Farther north, and also in eastern Asia, and in America, where the isothermal lines bend towards the equator, the increments are still more considerable.

As two hours of the day indicate the temperature of the whole day, there must also be two days of the year, or two decades, whose mean temperature is equal to that of the whole year. From the mean of ten observations, this temperature of the year is found at Buda in Hungary from the 15th to the 20th of April, and from the 18th to the 23d of October. The ordinates of the other decades may be regarded as functions of the mean ordinates. In considering the temperatures of entire months, we find, that to the isothermal line of 35°.6, the temperature of the month of October coincides (generally within a degree) with that of the year. The following Table proves that it is not the month of April, as Kirwan affirms, (*Estimate*, &c. p. 166.), that approaches nearest to the annual temperature.

Names of Places.	Mean Temperature			Names of Places.	Mean Temperature		
	Of the Year.	Of October.	Of April.		Of the Year.	Of October.	Of April.
Cairo, -	72°.3	72°.3	77°.9	Gottingen,	46°.9	47°.1	44°.4
Algiers, -	69.8	72.1	62.6	Franeker,	52.3	54.9	50.0
Natchez,	65.0	68.4	66.4	Copenhagen,	45.7	48.7	41.0
Rome, -	60.4	62.1	55.4	Stockholm,	42.3	42.4	38.5
Milan,	55.8	58.1	55.6	Christiania,	42.6	39.2	42.6
Cincinnati,	53.6	54.9	56.8	Upsal, -	41.7	43.3	39.7
Philadelphia,	53.4	54.0	53.6	Quebec,	41.9	42 8	39.6
New York,	53.8	54.5	49.1	Petersburgh,	38.8	39.0	37.0
Pekin, -	54.7	55.4	57.0	Abo, -	41.4	4 .0	40.8
Buda, -	51.1	52.3	49.1	Drontheim,	39.9	39.2	34.3
London, -	51.8	52.3	49.8	Uleo, -	33.1	37.9	34.2
Paris, -	51.1	51.3	48.2	Umeo, -	33.3	37.8	34.0
Geneva, -	49.3	49.3	45.7	North Cape,	32.0	32.0	30.2
Dublin, -	48.6	48.7	45.3	Enontekies,	27.0	27.5	26.6
Edinburgh,	47.8	48.2	46.9	Nain, -	26.4	33.1	27.5

As travellers are seldom able to make observations for giving immediately the temperature of the whole year, it is useful to know the constant ratios which exist in each system of climates, between the vernal and autumnal temperatures, and the annual temperature.

The quantity of heat which any point of the globe receives, is much more equal during a long series of years than we would be led to believe from the testimony of our sensations, and the variable product of our harvests. In a given place, the number of days during which the N.E. or S.W. winds blow, preserve a very constant ratio, because the direction and the force of these winds, which bring warmer or colder air, depend upon general causes,—on the declination of the sun,—on the configuration of the coast,—and on the lie of the neighbouring continent. It is less frequently a diminution in the mean temperature, than an extraordinary change in the division of the heat between the different months, which occasions bad harvests. By examining between the parallels of 47° and 49° a series of good meteorological observations, made during ten or twelve years, it appears, that the annual temperatures vary only from 1°.8 to 2°.7; those of winter from 3°.6 to 5°.4; those of the months of winter from 9° to 10°.8. At Geneva, the mean temperatures of twenty years were as follows:

Years.	Mean Temp.	Years.	Mean Temp.
1796,	49°.3	1806,	51°.4
1797,	50.5	1807,	49.3
1798,	50.0	1808,	46.9
1799,	48.7	1809,	48.9
1800,	50.5	1810,	51.1
1801,	51.1	1811,	51.6
1802,	50.9	1812,	47.8
1803,	50.4	1813,	48.6
1804,	51.1	1814,	48.2
1805,	47.8	1815,	50.0
Mean of 20 Years,			49°.67

If, in our climates, the thermometrical oscillations are a sixth part of the annual temperature, they do not amount to one twenty-fifth part under the tropics. I have computed the thermometrical variations, during eleven years, at Paris, for the whole year, the winter, the summer, the coldest month, the warmest month, and the month which represents most accurately the annual mean temperature; and the following are the results which I obtained:

Observations of M. Bouvard.	Mean Temperature					
	Of the Year.	Of Winter.	Of Summer.	Of January.	Of August.	Of October.
Paris, 1803, -	51°.1	36°.7	67°.6	34°.3	67°.6	50°.5
1804, -	52.0	41.0	65.5	43.9	64.6	52.7
1805, -	49.5	36.0	63.1	34.9	64.8	49.3
1806, -	53.4	40.6	65.3	43.0	64.6	51.8
1807, -	51.4	42.3	67.8	36.1	70.5	54.3
1808, -	50.5	36.7	66.2	36.3	66.6	48.2
1809, -	50.9	40.5	62.4	40.8	64.2	49.6
1810, -	50.9	36.5	63.3	30.6	63.7	52.9
1811, -	52.7	39.2	65.1	26.6	63.7	57.6
1812, -	49.8	39.6	63.1	34.7	64.2	51.1
1813, -	49.8	36.1	61.7	32.5	62.6	53.1
Mean of these 11 years,	51°.1	38°.7	64°.0	36°.6	65°.1	51°.9

At Geneva, the mean temperatures of the summers were, from 1803 to 1809,—

Years.	Mean Temp of Summers.
1803, -	67°.3
1804, -	65.0
1805, -	62.2
1806,	65.7
1807, -	68.2
1808, -	62.9
1809, -	63.0
Mean of seven years,	64°.9

M. Arago has found, that in the two years 1815 and 1816, the last of which was so destructive to the crops in a great part of France, the difference of the mean annual temperature was only 2°, and that of the summer 3°.2. The summer of 1816 at Paris was 59°.9, 4°.7 below the mean of the former. From 1803 to 1813, the oscillations round the mean did not go beyond —2°.9, and +3°4.

In comparing places which belong to the same system of climates, though more than eighty leagues distant, the variations seem to be very uniform, both in the annual temperature and that of the seasons, although the thermometrical quantities are not the same.

Years.	Paris.		Geneva.		Paris.		Geneva.		Paris.		Geneva.	
	Mean Annual Temperature.	Difference between Mean Ann. Temp. and that for 12 years, 51°.1	Mean Annual Temperature.	Difference between Mean An. Temp. and that of 12 years, 49°.6.	Mean Temperature of Winter.	Difference with the mean Winter Temperature of 12 years, 38°.7.	Mean Temperature of Winter.	Difference with the Mean Winter Temperature of 12 years, 34°.9.	Mean Temperature of Summer.	Difference with the Mean Temrature of Summer for 12 years, 64°.6.	Mean Temperature of Summer.	Differencc with the Mean Temperature of Summer for 12 years, 64°.9.
1803,	51°.1	0	50°.4	+ 0.8	36°.7	— 2.0	32°.2	— 2°.7	67°.6	+ 3°.0	67°.6	+ 2.7
1804,	52.0	+ 0.9	51.1	+ 1.5	41.0	+ 2.3	38.3	+ 3.4	65.5	+ 0.9	66.2	+ 1.3
1805,	49.5	— 1.6	47.8	— 1.8	36.0	— 2.7	33.8	— 1.1	63.1	— 1.5	63.0	— 1.9
1806,	53.4	+ 2.3	51.4	+ 1.8	40.6	+ 1.9	38.5	+ 3.6	65.3	+ 0.7	64.6	— 0.3
1807,	51.4	+ 0.3	49.3	— 0.3	42.3	+ 3.6	35.8	+ 0.9	67.8	+ 3.2	68.2	+ 3.3
1808,	50.5	— 0.6	46.8	— 2.8	36.7	— 2.0	33.8	— 1.1	66.2	+ 1.6	63.5	— 1.4
1809,	50.9	— 0.2	48.7	— 0.9	40.5	+ 1.8	35.1	+ 0.2	62.4	— 2.2	63.1	— 1.8
1810,	50.9	— 0.2	51.1	+ 1.5	36.5	— 2.2			63.3	— 1.3		
1811,	52.7	+ 1.6	51.8	+ 2.2	39.2	+ 0.5			65.1	+ 0.5		
1812,	49.8	— 1.3	47.8	— 1.8	39.6	+ 0.9			63.1	— 1.5		
1813,	49.8	— 1.3	48.6	+ 1.0	36.1	— 2.6			61.7	— 2.9		

(To be continued in next Number.)

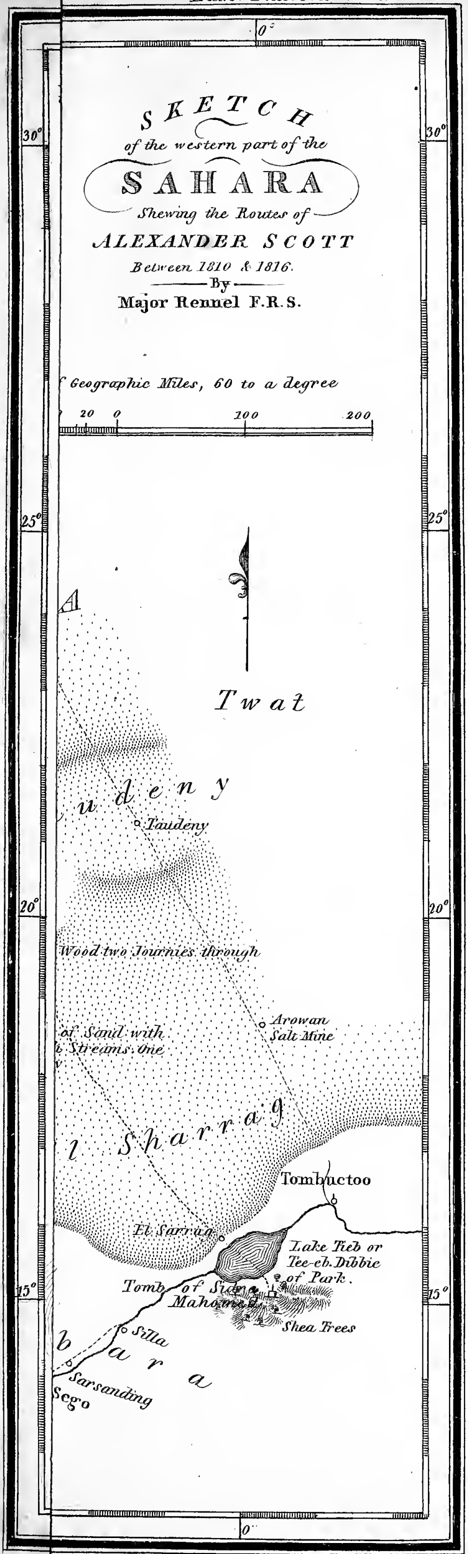
Art. IV.—*Account of the Captivity of* Alexander Scott, *among the Wandering Arabs of the Great African Desert, for a period of nearly Six Years. With Geographical Observations on his Routes, and Remarks on the Currents of the Ocean on the North-Western Coast of Africa, by* Major Rennell, F. R. S. &c. &c. &c.*.

[This account was drawn up by my friend Mr William Lawson and myself, from notes of many conversations with Alexander Scott, immediately after his return from Africa. He was repeatedly examined by us, both separately and in conjunction. Whilst we guarded as much as possible against stimulating his invention by the nature of our questions, we enforced the necessity of strictly adhering to matters of fact; and the result of our intercourse with him, is a conviction, that what he relates may be depended on, as far as his opportunities and talent for observation extend. His story, remarkably free from personal adventure, or suspicious affectation of accuracy in dates and distances, appeared to us always consistent. Like other persons who have experienced the horrible tyranny of the inhabitants of the African Desert, Scott at first exhibited a considerable degree of mental apathy. We probably have not exhausted all his stock of information; we conceived that the cause of truth would be best served, by chiefly contenting ourselves with what he spontaneously uttered. This account might have appeared more interesting, had it been drawn up as Scott's *Own Narrative;* but this would have deceived the public. We have, however, adhered strictly to his meaning; and, as nearly as we could with propriety, to the language of an ill-educated seaman. The MS. was submitted to the late excellent President of the Royal Society of London, and to our illustrious geographer Major Rennell. The information it contained appeared to them so important, that the latter gentleman has been induced to furnish a Map, and the two very valuable Dissertations annexed to this paper.

Liverpool, 24th Oct. 1820. Thos. Stewart Traill.]

Alexander Scott, a native of Liverpool, at the age of sixteen years, sailed as an apprentice in the ship Montezuma, commanded by Captain Knubley, and belonging to Messrs J. T. Koster and Company of that port. The vessel sailed on the

* It was the original intention of Dr Traill to publish this Narrative in a separate volume, for the benefit of Scott's friends. Upon submitting it, however, to an eminent publisher, it was deemed too short for a separate work; and I availed myself of the opportunity which this circumstance presented, of acquiring it for this Journal.—D. B.



Engd. by W. Archibald.

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26th October 1810 for Brazil, but was wrecked on 23d November at 3 o'clock in the morning, on the African coast, somewhere between Capes Noon and Bojador. In the course of the first day, the crew who had reached the shore, were visited by two persons (one of whom was a Negro,) belonging to the Arab tribe of Tobórlet. They had with them a camel. Scott, the cook, and a Portuguese boy, named Antonio, were desired by Captain Knubley to accompany those men to their habitations. The natives finding that Antonio had a knife and some copper-coin, took his knife, and cut away the pocket containing the money; in consequence of which, the Portuguese refused to go farther, and returned to the coast. Scott and the Cook proceeded chiefly on foot, but occasionally riding on the camel (after their fears at its appearance had subsided,) for eight or nine hours, when they arrived at a valley called Zérrohah, on the sides of which about 100 small tents were scattered. These tents were low, and formed of a coarse mat-like stuff, manufactured by the Arabs, of the hair of goats and camels, intermixed with wool. There might be about six or seven persons inhabiting each hut; their complexions were very brown; both men and women were bony and slender. Scott and his companion were consigned by their guides to the care of some women.

Next day the Captain and the rest of the crew arrived; but on the following day Scott was carried by the same two men who had been his guides, to other tents about two miles off. He remained altogether about three weeks at those two places; during which period all the people were scattered about, but Scott and Antonio remained together. They had skins to sleep on, and a thick porridge of barley-meal for food. Scott had remarked, that two pigs, saved from the wreck, had been killed by the Arabs; but their flesh was either left on the beach or thrown into the sea.

The Arabs now began to break up their tents, and sold Scott to an old man, named Sidi El Hartoni, who had with him three camels. He carried Scott away, and they fell in on the evening of the same day with another Arab, who had purchased the remainder of the crew, with the exception of the captain, a passenger, and two seamen.

On the following morning, the old man carried Scott to the spot where the vessel had been wrecked, and there they remained for three days. From thence they departed for the south, and after two days, during which Scott occasionally rode on a camel, he fell in with the Portuguese boy in possession of another Arab tribe, also moving southward. Here the two boys attempted to escape from their masters, but were pursued, caught, and beaten. They were immediately finally separated; Antonio and his master set off in a SE. direction, and Scott was carried, as near as he could judge, due south, travelling all the way not far from the sea, sometimes within sight of it, and occasionally along the beach. Their route was continued for fifteen days more, and the rate of travelling he estimates at fifteen miles a day; every night they rested at the tents of some tribe, and were always hospitably received.

The country they traversed principally consisted of a soft sand. A part of the road lay through a valley, watered by a salt river, and containing a deep thicket or wood, in which Scott observed trees resembling firs, and some from which whitish gum exuded. This last had sharp spines, the stem thicker than a man's body, not very high, growing, as Scott expresses it, "all of a rook *." This valley is named Wad Seyghi, (*Wad*, in the language of the country, signifying a valley, in which there is running water) †. Here Scott saw an animal, which he describes as "a large beast almost like a cow, covered with hair of a grey colour, with large horns, thick at the root, and spreading outward, a very short tail, and feet like those of sheep. This animal is eaten by the Arabs, who call it Row-y-ând ‡." After the seventeen days travelling, they came to an encampment of thirty-three tents, in a part of a district, which Scott says is named *El Ghiblah*, and is bounded on the west by the sea. Here they remained several months. The place of their abode was the highest part of that country;

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* *Rook* is a Lancashire term for a heap or close bundle. This tree is perhaps an Acacia.

† It is thought by competent judges, that *Wad* signifies a Valley, with or without water, and is certainly employed to denote a valley without running water.

‡ The Buffalo apparently.

its soil is principally rocky; its distance Scott computes at upwards of 200 miles southward of the place where he was sold to Sidi Hartoni, and he supposes it to be about twenty miles from the ocean, the roar of which he occasionally heard when the wind blew from the west. He also remarked a circumstance which inclined him to think the coast not far distant. The water of the wells at the beach was much fresher than that of the place of encampment, and the Arabs, who were often sent to fetch it from the coast, usually left home in the morning, and returned on the evening of the following day.

In this district Scott saw "plenty of wild-fowl, occasionally foxes, wolves, *deer*, or animals like deer, with a red back, white belly, tapering black horns, with prominent rings, and tips bent forward, eyes black and large. Some of these animals have straight horns:—it is called El Mochae *."

Scott remained at El Ghiblah for some months, but about the month of June (as he supposes, from his recollection of the length of the day and the heat of the weather,) he was told that "the tribe would go a long journey to *Hez el Hezsh*, and that he must go with them, and there change his religion, or die."

The old man, his master, his three sons and three daughters, with many others of the tribe, composed a caravan of twenty families.

The party mustered between 500 and 600 camels, of which fifty-seven were the property of Sidi El Hartoni. Each family was provided with a tent, which, with provisions, water, and all their effects, were carried by the male camels, while the young camels, and those that gave milk, had no load whatever. The number of sheep belonging to the caravan was above 1000, and their goats were nearly as many. They had only five horses, which during the journey were chiefly employed in chasing ostriches, the feathers of which were carefully

* On shewing Scott the plates in Shaw's Zoology, he immediately pointed to the following animals as those which he had met with in the African Desert and its confines, while he described the peculiarities of each with considerable accuracy: Antilope oryx, or Egyptian antelope; A. gazella, A. cervicapra, or common antelope; A. euchore, or spring antelope.

preserved, and the flesh eaten. They carried with them two jack-asses, and many dogs, chiefly of the greyhound and bloodhound breed, with which the people killed hares, foxes, and wolves; and on the flesh of all these this tribe occasionally fed. When travelling, the sheep and goats of each family were kept in separate droves. The animals go close together, except where they meet with some vegetation, when they spread, but are easily brought together by the whistling of their driver, or by the sound of his horn. The latter is the most usual method, and soon collects the flocks around the driver, an effect supposed to arise from their apprehension of wild beasts, which drives them to the protection of their keeper. It is said, that they can distinguish by the smell the approach of a wolf at the distance of half a mile.

The tents were pitched every night, and the camels and flocks belonging to the family were disposed in front of the family tent, near which fires were kindled for cooking. Should there be any apprehension of an attack during the night, all the tents are pitched in a circular encampment called Douâr, within which all the cattle are driven, and the men lie among the camels, which immediately rise up on the first alarm.

The sheep and goats are very different from those of England, being much larger, with longer legs, and are much accustomed to travelling. When they have sufficient food, they will keep up with the camels on a journey, and they can occasionally run as fast as a greyhound.

The camels can go long without food or drink; they browse on the scanty herbage of the desert, where they find it, and drink as much at once as will serve them a long time. Scott never saw or heard that this animal ever swallowed *charcoal*, and thinks, that had this substance ever been its food, he must have observed it, as he has often seen the camels reduced to great extremity for want of herbage.

For the first four or five days, the route of the caravan lay over hard clayey ground, very barren, producing only wild bushes, but not a blade of grass. They then came to a sandy district called El-e-Buscharah, consisting of hills and valleys of sand, having water only at a deep well about ten miles southwards of the place where they entered on it. From this well the camels were loaded with water. The Arabs told Scott that this well had been made by Christians, who once possessed this country, until expelled by the Moors or the Arabs.

In this sandy district they saw no beasts, except a few deer in the valleys. Scott describes these deer as of a nankeen colour, with black stripes along their sides, near the belly; the nose, eyes, and tongue black; the male had small straight horns without branches, the females none; their legs were long and slender; they were so fleet that the greyhound scould not catch them; their size was inferior to that of an English sheep *.

The only vegetation of this country was small bushes, and a low tree, called by the Arabs *El Myrreh*. The tallest of them is about three yards high, it has a red broad branch like a palm, and running roots like liquorice, about as thick as the finger, and sweet as sugar; the roots are called *Ferrada* by the people, and eaten both by them and the cattle. The cattle were fond of this root as food, and it was reckoned good for them.

There were here some birds, and the eggs of various wildfowl were found in the sand, among which Scott particularly mentions one by the name of *Wild Peacock* †.

For eleven days their route lay through this sandy district, and then they entered upon a more firm sort of soil, which sometimes presented a hilly surface, and occasionally extensive plains of hard clay, sprinkled over with some bushes, but without any other vegetation. The hills sometimes shewed rocky sides, on which "dry mosses" ‡ grew. This sort of country continued for about two months, during which they went through several valleys containing small streams of water, so brackish that it could not be drank; and they passed by some mines of salt, and brimstone. The former appeared like white rocks in some valleys, and the latter looked like white and yellow rocks. Scott knew the salt by its taste; and having broken off a piece of the brimstone, he found it to be very *bitter*, and

* This is evidently an Antelope, and probably a new species. It has some affinity to the Antilopè oryx.

† Perhaps a bustard.

‡ Lichens.

on throwing it on the fire at night, it burnt with a blue flame, and almost suffocated the people, who beat him heartily for causing this annoyance *.

The tracks left by camels in the clay soil, in wet weather, (which is not very frequent in that country,) guided the caravan through this desert region. They often met other Arab tribes travelling like themselves, but they never pitched their tents near each other. This arose partly from fear, and partly from the scarcity of water and food for their cattle.

After passing through a wood, which they traversed for two days, they again came to a sandy soil. This wood was the boundary between the clayey and sandy districts. During their passage through the forest, they saw several lions, which did not attempt to come near them.

Scott remarked, that beasts of prey seldom attacked a party unless they were first molested; but their flocks were attacked in this wood by a tiger †. The camels can smell this animal at a considerable distance, and its approach is known by their refusing to advance. This occurred in the wood, the men prepared their arms, the tiger approached with little noise, and fell upon the sheep; the people endeavoured to drive him away, and fired at him, on which he suddenly turned on them, killed three, two of whom he struck down at once, and wounded five others. He then seized a sheep, which he carried off with great ease, in his mouth.

In this wood they met with a party who had a tame elephant. These people were of a darker complexion than the tribes of El Ghiblah. They belonged to the tribe of Or Ghêbet, and came from El Sharrag, and said they were going to some town (the name of which Scott did not hear) to fetch corn. They cautioned the Arabs with whom Scott was, to beware of a people called *Baurbarras*, black savages, who lived in the wood, and had done them much damage. In the wood were date-trees, cocoa-trees, and *wild oranges*.

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* The *bitter* taste perhaps arose from a mixture of Sulphate of magnesia, which occasionally occurs with sulphur; or it might be owing to Sulphate of ammonia.

† From Scott's description of this animal, it would appear to be the Panther.

On leaving the wood, the caravan entered on the sandy district already noticed. It was varied by valleys and small sandy hills, and was watered by many running streams a little brackish; although the weather had been long hot, and very little rain had fallen. In about a month they got through this sandy district; and, without having had any distant view of it, arrived on the shores of a vast *lake* or *sea*. The day was extremely clear, and two mountain tops on its opposite shore were just visible, almost like clouds on the sky.

The point at which they arrived was not that which they had intended to reach; for it was an uninhabited country. They proceeded, therefore, northward, along the banks of the lake, and in the evening arrived at a number of *fixed huts, built of canes and bamboos, called El Sharrag*, and belonging to the Or Ghêbets. The surrounding country was of a soft sandy soil, not much wooded. There were many low bushes; and near the beach high trees, with tall stems, and bunches of leaves at the top, something like a cocoa-tree, but taller.

From the time of their leaving El Ghiblah, until their arrival at the lake, the route of the caravan was pretty uniformly in one direction, except when the intervention of hills or rivers caused occasional deviations; but as soon as these obstacles were passed, they resumed the original direction.

Scott was unprovided with any means of determining the true line of their march, but, judging from the position of the sun at his rising, it appears, that at setting out, the line of route lay a little to the southward of east, and gradually inclined more to the south as they advanced *.

They travelled more or less every day, except when they tarried three days in the wood, to bury those who had been killed by the *tiger*. The first day was, in consequence of this occurrence, a day of rest; the second was employed in burying the dead; and the third was occupied in placing stones over the graves, to secure them from wild beasts. Some days,

* Unfortunately there are no more precise data from which this important point can be ascertained; and this mode of estimating by the eye, especially in the observations of an ill educated lad sixteen years of age, cannot be considered as any thing more than a rough approximation to the true line of route.

when very hot, they stopped at 2 or 3 o'clock for the day. Scott was of opinion, that the distance travelled was generally twenty miles, and seldom less than fifteen miles a-day.

In all this journey, they did not pass through, nor did they see any thing that could be called a town, nor any permanent habitations of any kind, until they reached the lake. They did not pass near, nor did they cross any high mountains. They did not meet with any large river or stream which was not fordable. They frequently met other parties like themselves, who all spoke Arabic, which Scott now began to understand tolerably well; but many of them spoke also another language.

During the journey those who chose rode on the camels; the women and children often did: Scott was permitted to do so sometimes. Scott's occupation was chiefly to attend to his master's sheep and goats, in which he was assisted by one of his master's daughters; and at night he was employed in grinding or bruising barley between two flat stones. The Arabs fared very scantily, and Scott still worse. His feet and legs were blistered by the burning sand: he was cruelly beaten for trifling faults, and if he slept too long in the morning, he was beaten with a cudgel. The whole party were often short of water; and at one time, when travelling over the hard ground near the salt and brimstone mines, they were in great distress, having been six days without any water. Their resource then was the milk of their goats and camels; and they frequently collected the urine of the latter, as a drink in this extremity, or preserved what water was found in the stomach of those that died. The urine of the camel is ocasionally taken as a purgative medicine. It is usually given for three successive mornings, and operates much on the bowels. The Arabs did not take breakfast; they generally had only one meal a day, and that after sunset. It consisted usually of goat's milk and a thick porridge of barley flour; but if they had no corn, they drank the milk of their goats and camels, and ate the flesh of the camel, whether the animal died a natural death, or was killed accidentally or on purpose. They even occasionally devoured the hide of the camel, which is tough and thick. It is first beaten quite thin between two stones, and then it is roasted. A large fire of wood is kindled on the ground, the glowing embers are mixed with the sand, and the hide, or other animal food, is covered over with the mixture, when it is soon roasted, and devoured by the Arabs, without any nice attention to the particles of sand which may be adhering to it. They also occasionally eat locusts, which are roasted in a similar manner.

At El Sharrag, all the camels, sheep and goats, belonging to the party, with two persons of each family, were left, and a large boat was hired to convey them across the lake. This boat was very long,—was built of a red wood, something like mahogany, —appeared to have no iron about her,—and even her rudder was fastened by ropes of straw or grass. Between seventy and eighty of their party embarked in this boat, amongst whom was Scott. The boat was commanded by an Arab of a darker complexion than those with whom Scott had travelled, and manned by six blacks, whom Scott considered to be slaves, from the treatment they experienced from their master; for he observed, that they, as well as other Negroes, who are numerous at El Sharrag, were often beaten by the Arabs. The boat started at sunrise, and was rowed with six oars, until a little before sunset, at a rate (as Scott imagined) of about two miles an hour. The oars were very short and clumsy; the blacks sat two on the same seat, with their faces to the stem, rowing with quick and short strokes, and raising the body at each stroke, not sitting steady, and making a long pull, as English sailors do. They rested half a dozen times through the day, for about ten minutes or a quarter of an hour at a time. A little before sunset, a large stone, which served as an anchor, was let down with about twenty fathoms of cable, and the boat remained stationary all night. They weighed anchor again at sunrise, proceeded as before, till sunset, and then again cast anchor. Soon after daybreak on the third day, they again got under weigh, and proceeded until about two o'clock in the afternoon, when they arrived at the opposite shore. Their course was straight for the two mountains already noticed, and they landed at their foot, in a country called *El Hezsh.*

The lake is named *Bahâr Tieb* *. Judging by the position

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* According to Scott, "*Bahar* signifies a water on which boats can go," and "*Tieb* or *Tee-eb*, fresh." The name is therefore the "Fresh Water Lake or

of the rising sun, Scott thinks that the greatest extent of this Bahar is from N.E. to S.W. When on it, he could not perceive any boundary in those directions; and he was given to understand that it extended very far in both *. Its breadth he could not state, except as far as an inference may be drawn from the time they took to cross it, at this, which seemed its narrowest part †. The water during their passage was smooth, with a great deal of weeds floating on its surface. Some had broad green leaves, but none of them looked like sea-weeds. All resembled fresh-water weeds, and abundance of rushes grew near the shore. The water under the weeds was clear, and fresher than that of the country, which was all brackish. When further questioned, Scott stated, that though the water of the Bahar was comparatively fresh, yet it would not be reckoned fresh in this country. The Bahar had no perceptible current; had any such existed, he could not have failed to observe it. Both nights when the boat was brought to anchor, the bow was as nearly as he can recollect towards the moon, when rising about 10 o'clock ‡; and he remarked that its position did not appear to be changed during the night. The sky was cloudless, the winds were calm, and a very heavy dew fell. The moon was full, two or three days before they crossed the Bahar. The Bahar contained turtles, something like those brought to England from the West Indies, but much smaller: of these Scott killed some, but did not eat them. Fish of different kinds

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Sea." For its accordance with the Dibbie or Dark Lake of Park, See Major Rennell's Remarks on this Narrative, which will be printed in next Number.

* See Major Rennell's Memoir.

† Suppose their course the first day 12 hours,
the second day 12
the third day 8

we have for the whole 32 hours;
but we must deduct for the resting of the rowers, 3 hours,

which leaves for the whole sum - - 29 hours;
and this, at the rate of two miles per hour, would indicate fifty-eight miles as the breadth of the Bahar at this point. We may perhaps say, in round numbers, sixty miles.

‡ Rather about 8^h or $8\frac{1}{2}^h$ by the moon's age.

abounded in the water, and were caught with great ease by nets let down from fishing-vessels, or hauled on the beach. He saw some like mackrel, others shaped like eels, but thicker and much larger. Some had no scales; but he did not see any with long feelers at their mouths.

There were many fishing-vessels on the Bahâr, but no boats larger than that which conveyed them across the lake, which was capable of carrying about 200 people. Its ends were both alike, rising up like those of a canoe, very sharp, decked for about three yards at each end, with several *thwarts* or seats for the rowers across it, on each of which two men sat when they rowed, each with a separate oar. The boat was very flat-bottomed, was ceiled in the bottom and up the sides, had no mast, but there was a *step* for one in the keel, and a hole in the seat over it. The cable was formed of a rushy grass, which he was told is taken when green, is flattened by beating it when wet, and then twisted into ropes, which become afterwards yellow. The boat in the language of the Arabs is called *zourgos*, but by the natives of El Sharrag and El Hezsh *flook*.

With the master of the vessel, Scott had no opportunity of speaking. This man wore a white cotton shirt, with a red girdle, and was armed with a musket and cutlass. The dress of the boatmen had some resemblance to an English carter's frock, but was made of woollen *. They all wore yellow slippers, lined with red, and of the same width from the toe to the heel †. These people spoke the Arab language, and also another called *Schlech.* In the former Scott conversed with them, and found that they were apprehensive of being attacked while on the water, by people who come from the upper or northern part of the *Bahâr* in boats, and who inhabit the eastern side of that part; are small in size, and are a different race from the Arabs. Scott thinks they told him, that this race (whom they named *Zachah*) do not believe in Mahommed.

The boatmen also told him, pointing to the southward, *that in that direction lay a great salt-water sea; that the one they*

* This is a pretty accurate description of the dress of the poorer class of Moors on the northern coast of Barbary.

† This is the exact counterpart of the Barbary Slipper.

then were on run into it; that there was no end of it; that there were plenty of Saffina el Kabeer, or large ships on it; and that they called it Bahâr el Kabeer *. They stated, that to the southward was a harbour called *Bambarry* †, where a great number of ships came. They further stated, that a long way to the southward (pointing in that direction), and before they were born, there had been great battles, both on the Bahâr el Kabeer and on land, between the French and English ‡; that where the battle had been fought on the land, the bones of those killed were yet lying.

At the place where the party landed were a number of huts built of logs of wood, placed perpendicularly, lined with canes on both sides, with bushes in the intervals, and covered with rushes taken from the banks of the Bahâr. The name of this place is *El Tah Sidna Mahommed*, signifying "The place of a chief called Mahommed;" and the name of the tribe is *El Tahsi del Hêzsh*. On landing, the Arabs all kissed the ground three times, and *washed* their hands and faces with sand, as they did at all times when they prayed. Scott refused to do so, and the men beat him with a stick; but the women begged he might not be further punished. They remained all night at these huts, but the next morning at sun rise, they left the village, taking Scott along with them, and telling him they were going to *Hêz el Hêzsh*, to *Sidna Mahommed;* that he must go there, change his religion, and be circumcised; and that if he did not become of their religion, Mahommed would rise up and kill him.

The country bordering on the sea was sandy, but a little way back it was a mixture of sand and clay, with many large rocks which were quite "full of *chinney weed*," called in Arabic *Tomkilet* §. They then traversed a mountainous country, by a

* Great Sea or Water.

† There is a district not far to the south of the Congo River called Bamba, where the Portuguese have been in the habit of *slaving*. But the bones, the fighting, and the river, must, in M. Rennell's opinion, all belong to different stories. Scott was *young* in Arabic; and the Arabic was not the vernacular tongue of his informant.

‡ When questioned on this head, Scott affirmed, that he is "certain they said Frencese and Inglese." These negroes were probably slaves brought from a distance.

§ *Chinney* is the vulgar name for archil,—a substance prepared chiefly from Lichen Roccella.

winding path (which tended southward,) until about 3 o'clock in the afternoon; when they arrived at a valley between two high mountains, the sides of which produced large oil trees. The branches of this tree resemble an oak, and produce "green *plums*," with a hard shell and a kernel in each, which, when boiled, affords oil *. The process for obtaining this oil is as follows: The nuts are broken, the kernels dried in the sun, then ground, and boiled with water in clay-pots; the oil is skimmed off as it rises.

The valley is about three quarters of a mile across, there was no grass in it; but small bushes grew in a clayey soil, mixed with a black slaty stone.

Here stood a solitary building, "about the size and shape of an English barn, or haystack." The lower part was formed of rough red rockstones, bedded in clay; the upper of canes and boughs of trees: the whole was covered with rushes. It appeared as if it had been long built, being quite black with moss on the outside. One end of this building was to the north, and the other to the south. In the south end was a square headed door, which was not opened while Scott was there. There was no window, nor any thing like a chimney, or other projection, except a long pole forked at the end, rising out of the rushes on the east side of the roof, and sloping upwards. It was so long that the forked ends were beyond the line of the wall, and each extremity was covered by an ostrich egg. Immediately below these was a large wooden bowl capable of holding five or six gallons, and placed on three large stones, which supported it about two feet from the ground. This building they told him was the grave of *Sidna Mahommed.* This, he says, does not mean *the grave of the Prophet*, whose title among them is Uhrr soēl †, but of some great man connected with, or a relation of

* This is no bad description of the Shea-Tree. See Park's First Journey.

† Before receiving this account of the grave, he had been told that it was the burial place of the Prophet Mahommed, (as he supposes, with the intention of more readily inducing him to change his religion,) but having read when at home, in some book respecting the East Indies, that Mahommed's burial place was *Mecca*, which is a large town, and that his coffin was hung up in a large church; he therefore knew that this story could not be true. After his return to El Ghiblah, he was told that another great man called Sidna Ali, was buried in the build-

Mahommed the prophet. The personage here buried was laid (as he was told) on his side with his head to the north, his feet to the south, and his face to the east *, the usual mode of interment in that country. In the ground adjoining the building, were the graves of many pilgrims who had died in *El Hezsh.* These were marked by small hollows, with a stone upon each, with other stones placed on edge along the sides, and one at each end.

The party was accompanied by five pilgrims, who were dressed in a kind of white cotton shirt, with a red belt round the waist, and each carried a brass box containing books and papers. When they had arrived on the ground, all, in a standing position, cried aloud: "*Allah ackibar shedou il lahi el allah.—Shedowna Mahommed de rassoul allah* †." They bowed their heads thrice to the ground, then got up, and walked to the front of the building, to the door of which, the pilgrims first approached. On one side of the door was a brownish stone, set in the ground two feet high, which the pilgrims kissed, and their example was followed by all the party, Scott excepted. The stone was quite smooth and rounded at the top, seemingly hard and clean, but the sides were rather mossy.

The people here threatened to kill Scott, if he did not turn Mahommedan, shewing him a knife with which they said they would destroy him. He told them "they might kill him, for "he would not turn;" and they gave him until next morning to think of it; but after this time they did not trouble him any more about changing his religion.

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ing above described; that this person was born where the Prophet was, and married his daughter Fatma-Min t' Uhnsoel, who is also interred there. Scott's master likewise read to him from a book, the names of many who were buried in the above described building, some of which he recollects, as Sidna Braheim, Sidna Mouss, Sidna Bak-har, Sidna Hammed, Sidna Bo-heida, Sidna Solleh.

The errors in Scott's description of the tomb of Mahommed, and *of the place of his burial,* are not uncommon in such popular works as he probably consulted.

* That is towards Mecca.

† These words are put down as nearly as possible, according to his manner of pronouncing them, as are the proper names which occur in the narrative. Compare this sentence with Ali Bey's *Account of the Religion of the Western Arabs,* vol. I. p. 89. and 90.—and the ceremony of kissing the stone of the Kaba, vol. II. p. 52.

Tents and provisions had been provided by the pilgrims, and the party staid all night in the valley. Next day some of them walked five or six miles into the neighbouring country, and saw three or four ruins of large buildings, one of which had walls standing, that were pierced by two or three square windows. The walls were of "rough rock-stone," with clay for mortar. These ruins covered a great deal of ground, and had evidently been once inhabited, but the people with whom Scott was, did not seem to know any thing about their former use. At night they remained in the tents, and next day returned to the sea-side. Before setting off, and also at day-break on the preceding day, the Arabs said their prayers at the building. During their stay on that side of the Bahâr, Scott was never again taken to the grave, though he believes that the party went to it almost every day *, with camels and mules. He was confined in the hut where he was lodged, and was never allowed to go farther than the door, in consequence of his refusal to become a Mahommedan †.

While he remained there, many people, some of whom wore red caps on their heads, came on mules and camels, as pilgrims from the southern side of the lake, to offer (as it was said) sheep and goats at the grave; and there were also frequent arrivals of parties like their own, who came in boats from the northern side of the water.

The people of El Hêzsh eat in the middle of the day as well as at night. Their food, as also that of the people of El Shanag, consists chiefly of *corn-bread* and dates; they making much less use of goats' and camels' milk, and camels' flesh, than the other Arab tribes do when stationary. They make, however, kouskusû ‡.

* It is customary with Mahommedans to pray at the tombs of their holy men; and this pilgrimage might be substituted for that to Mecca, the distance to which being too great for the wandering tribes to undertake.

† The firmness of Scott in this particular is highly praiseworthy. It had been reported before his return that he had renounced Christianity, and embraced the faith of Mecca; but the writer of this note has decisive proof, that he never had conformed to the ceremonies of that religion.

‡ An excellent African dish, much used in Morocco, made by seething a fowl in a pipkin filled with granulated flour; its juices are absorbed by the farinaceous matter, which is thus rendered very palatable. It is a pilau.

Their dress differs from that of the pilgrims already mentioned. It consists of a dark-blue linen shirt, a pair of short trowsers, which reach to the knees, a red girdle, a knife at their side, and a musket. Their legs are bare, and on their feet are slippers of yellow leather lined with red, or sandals.

The women have red slippers, bare legs, and a white *haïck* *, with a broad plate of silver hanging in front of each shoulder, and a belt of yellow and green worsted plaited together. "The "women of the head-men have a dark-blue *mĭllĭcha*," which is worn like the haïck of the inferior orders, but has its corners and edges fringed with the same colour, and they wear also a belt, which is sometimes all red, at other times white, or a mixture of yellow and green. The children wear a sort of woollen frock with short sleeves, which, with the breast of the frock, are worked with red worsted.

There are many black slaves at El Hêzsh. There are no houses better than the huts already described; but the latter are very numerous. Tents are also used, when a part of a family is obliged to go in quest of food for the cattle.

(To be concluded in next Number.)

ART. V.—*Table for determining accurately the Time of High Water at any given Port.* Computed by General Sir THOMAS BRISBANE, C. B. F. R. S. E.

THE object of the following Table is to determine accurately the time of High Water at any given port, by applying a correction dependent on the accelerated or retarded action of the Moon on the Tides in passing the given Meridian in her different parallaxes. The elements of this Table have been given by the Marquis de La Place in the Mecanique Celeste, and we have here only interpolated his quantities, so as to render the method more simple to those who are not conversant in such calculations.

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* This is exactly the dress of females in Morocco. The haick is a large shawl of cotton, in which the women are so enveloped, that nothing is visible except one eye, their slippers, and their bare heels.

Moon's passage over Merid. Hours.	Moon's passage over Merid. Minutes.	Moon in Perigee.	Moon in her mean Distance.	Moon in Apogee.	Moon's passage over Merid. Hours.	Moon's passage over Merid. Minutes.	Moon's passage over Merid. Hours.	Moon's passage over Merid. Minutes.	Moon in Perigee.	Moon in her mean Distance.	Moon in Apogee.	Moon's passage over Merid. Hours.	Moon's passage over Merid. Minutes.
		′	′	′					′	h ′	h ′		
0	0	— 4.0	0.0	+ 5.5	12	0	6	0	— 55.5	— 1.2.5	— 1.12.5	18	0
	10	— 6.1	— 2.6	+ 2.1		10		10	— 52.4	— 0.58.6	— 1. 7.6		10
	20	— 8.2	— 5.2	— 1.2		20		20	— 49.3	— 54.8	— 1. 2.8		20
	30	— 10.3	— 7.8	— 4.6		30		30	— 46.1	— 50.9	— 0.57.9		30
	40	— 12.5	— 10.5	— 8.0		40		40	— 43.0	— 47.0	— 53.0		40
	50	— 14.8	— 13.3	— 11.5		50		50	— 37.7	— 40.7	— 45.3		50
1	0	— 17.2	— 16.2	— 15.0	13	0	7	0	— 32.5	— 34.5	— 37.5	19	0
	10	— 19.6	— 19.1	— 18.5		10		10	— 27.3	— 28.2	— 29.7		10
	20	— 22.0	— 22.0	— 22.0		20		20	— 22.0	— 22.0	— 22.0		20
	30	— 24.3	— 24.8	— 25.5		30		30	— 16.7	— 15.7	— 14.3		30
	40	— 26.7	— 27.7	— 29.0		40		40	— 11.5	— 9.5	— 6.5		40
	50	— 29.1	— 30.6	— 32.5		50		50	— 6.3	— 3.3	+ 1.3		50
2	0	— 31.5	— 33.5	— 36.0	14	0	8	0	— 1.0	+ 3.0	+ 9.0	20	0
	10	— 33.6	— 36.1	— 39.4		10		10	+ 2.1	+ 6.9	+ 13.9		10
	20	— 35.7	— 38.7	— 42.7		20		20	+ 5.2	+ 10.7	+ 18.7		20
	30	— 37.8	— 41.3	— 46.1		30		30	+ 8.3	+ 14.6	+ 23.6		30
	40	— 40.0	— 44.0	— 49.5		40		40	+ 11.5	+ 18.5	+ 28.5		40
	50	— 42.0	— 46.3	— 52.0		50		50	+ 12.7	+ 20.0	+ 30.3		50
3	0	— 44.0	— 48.7	— 55.0	15	0	9	0	+ 14.0	+ 21.5	+ 32.3	21	0
	10	— 46.0	— 51.1	— 58.0		10		10	+ 15.2	+ 23.0	+ 34.1		10
	20	— 48.0	— 93.5	— 1.1.5		20		20	+ 16.5	+ 24.5	+ 36.0		20
	30	— 49.7	— 55.6	— 1.4.1		30		30	+ 16.2	+ 24.1	+ 35.5		30
	40	— 51.5	— 57.7	— 1.6.7		40		40	+ 16.0	+ 23.8	+ 35.0		40
	50	— 52.2	— 59.8	— 1.9.3		50		50	+ 15.7	+ 23.4	+ 34.5		50
4	0	— 55.0	—1.2.0	—1.12.0	16	0	10	0	+ 15.5	+ 23.0	+ 34.0	22	0
	10	— 56.1	—1.3.5	—1.13.5		10		10	+ 14.4	+ 21.7	+ 32.5		10
	20	— 57.2	—1.5.0	—1.15.0		20		20	+ 13.3	+ 20.5	+ 31.0		20
	30	— 58.3	—1.6.5	—1.16.5		30		30	+ 12.1	+ 19.3	+ 29.5		30
	40	— 59 5	—1.7.0	—1.18.0		40		40	+ 11.0	+ 18.0	+ 28.0		40
	50	— 59.7	—1.7.3	—1.18.5		50		50	+ 9.2	+ 15.9	+ 25.4		50
5	0	— 1.0.0	—1.7.7	—1.19.0	17	0	11	0	+ 7.5	+ 13.8	+ 22.8	23	0
	10	— 1.0.2	—1.8.3	—1.19.5		10		10	+ 5.7	+ 11.6	+ 20.1		10
	20	— 1.0.5	—1.8.5	—1.20.0		20		20	+ 4.0	+ 9.5	+ 17.5		20
	30	—0.59.2	—1.7.0	—1.18.1		30		30	+ 2.0	+ 7.1	+ 14.5		30
	40	— 58.0	—1.5.5	—1.16.3		40		40	0.0	+ 4.8	+ 11.5		40
	50	— 56.7	—1.4.0	—1.14.4		50		50	— 2.0	+ 2.4	+ 8.5		50
6	0	55.5	1.2.5	1.12.5	18	0	12	0	4.0	0.0	5.5	24	0

Method of Using the Table.

Example I.—Required the Time of High Water at Cork on the 21st October 1820, the Moon being in Perigee *?

Time of the Moon's passing the meridian, - -	12ʰ 13′
Correction in the Table corresponding to 12ʰ 13′, - -	— 7
Time of the Greatest Action of the Sun and Moon, -	12ʰ 6′
Time of High Water at Full and Change, - - -	4 54
Time of High Water required, viz. at 5 in the morning,	17ʰ 0

* The moon's horizontal parallax in the Nautical Almanack will determine whether the Moon is in her perigee, mean distance, or in apogee.

Example II.—Required the Correct Time of High Water at Leith on November 1. 1820, the Moon being in Apogee?

Time of the Moon's passing the meridian,	- -	$21^h\ 28'$
Correction in the Table corresponding to $21^h\ 28'$,	- -	+ 35
Time of the Greatest Action of the Sun and Moon,	-	$22^h\ 3'$

Art. VI.—*Outlines of* Professor Mohs's *New System of Crystallography and Mineralogy.* (Continued from Vol. III. page 342.)

IV. *Mineralogical System.*

1. Difference *between the Natural History System of Mineralogy and every other.*—As the natural history system of mineralogy deviates entirely from all previous systems, it will be necessary to shew that its deviations are nothing else than consequences from the universal principles of natural history. They regard, 1st, The form, 2d, The content *(inhalt)* of the system.

2. *Defect in form.*—No mineralogical system is known that has not a defective form. The defects of mineralogical systems, in regard to form, are of two kinds. In the *first* place, Those systems do not contain within them the essential steps of collocation or subdivision, *genera* and *species*; in the *second* place, The application of such steps as they do contain is not universal, and consequently the form is not the same throughout the whole system.

3. *Continuation.*—As to the *first* objection, it frequently happens, that where the species is settled according to the natural history plan, the genus is not so settled; and that where the genus is chemically settled, the species, at all events not chemically settled, is sometimes settled by natural history, frequently by good luck. Each of those two conceptions thus belongs to a different science,—one of them occasionally to no science at all. Hence if the system is observed from a point of view connected with the one of those sciences, the conception of Genus is wanting; if from a point of view connected with the other, the conception of Species is wanting. But a system to be observed under two points of view, *or a system with two aspects,* is itself a contradiction to logic. In this respect the Wernerian system is especially remarkable. In the class of Metallic Minerals, it really contains a sort of chemical genera, (the others only profess to be so); in the class of

Earthy Minerals, natural history families are combined along with those genera. Whoever is accustomed to use a system, will be as much astonished at those double genera, as at the total want of genera in some classes or orders of many systems.

4. *Continuation.*—Mineralogists have seldom been contented with the steps of classification, used in other departments of natural history. They have at one time rejected, at another appended, whatever seemed convenient. Perhaps this practice might be founded on satisfactory reasons; but if those reasons apply to one portion of a system, they likewise apply to all the rest, otherwise the system would be incongruous, that is to say, have no regular form. But regularity of form is absolutely inseparable from the idea of a system. And hence, if one class contain orders and genera, the others must contain them likewise, and so in other points. If we set out from right principles,—in natural history, from natural history principles,—this object is attained without difficulty or obstruction; but if in natural history, we set out from chemical principles, or in chemistry from natural history principles, it cannot be attained without constraint.

5. *The Natural History System is free from these faults.*—Whatever may be thought of the natural history system, it is not surely chargeable with any defect in point of form. It contains the two essential conceptions, genus and species, both settled upon *one principle*. It also contains classes and orders; thus conforming itself in its steps of classification to the general custom of natural history. In zoology and botany, a genus or an order is occasionally so extensive, that the inspection of it requires to be facilitated by a new subdivision. It is quite evident, that subdivisions of this kind do not belong to the essence of form. Mineralogy does not need them. The natural history system of mineralogy is likewise uniform throughout; in other words, it maintains through all its parts the same steps of classification; and these are everywhere of equal value,—a circumstance which does not happen universally in other systems of mineralogy.

6. *Defect of the content.*—As form is an essential part of every system, so the content of that system is not less essential. And here the natural history system is more or less distinguished

from all others. Probably the question as to the form will not occasion much difference of opinion. But in regard to the content more objections may occur; perhaps from the appearance of *the science itself being injured by rigorously observing the rules of natural history.* Following the clue which botany and zoology present, it is proper to institute some inquiry into this matter.

7. *Continuation.*—The content of a system is determined by the several species it includes. The deficiency of most mineralogical systems appears in the erroneous settlement of the species; as will easily be discovered, on comparing that settlement with our preceding conceptions of species (ii. 25.); and considering the multifarious transitions (ii. 30.) of one species into another. Since the idea of species, however, is a very simple one in mineralogy, and the application of it any thing but difficult; the question occurs, whence have so many defective arrangements arisen?

8. *Origin of this defect.*—The first source of them is, doubtless, to be found in the circumstance, that mineralogists have thought themselves obliged to admit into the system, a multitude of minerals not capable of any natural history arrangement. And in order to give this injudicious procedure a scientific air, they have next attempted to bring it under rules; whilst, in order to render it general, without attending to the numerous exceptions and alterations, they have applied it to other species, which might have followed the true principles of science. By this means, a multitude of species have been split asunder, although their correct arrangement would have tended to embellish the system.

9. *Explanation.*—A few examples will explain this. If *porcelain earth, green earth,* &c. are to appear as independent species, it will be necessary to produce some basis on which those pretensions to independence are founded. Their form, hardness, and specific gravity, by means of whose mutual relations the independence of species in the mineral kingdom is usually determined, are either so difficult to measure, in the cases before us, or so indistinct, that no methodical distribution can rest upon them. Recourse was therefore necessarily had to colour, connection of the particles, the feel, the adhesion to the tongue;

to which characteristics the requisite degree of importance was given, because otherwise the distribution must have been altogether arbitrary, or destitute of satisfactory grounds. Possessing such importance, those characteristics communicate a portion of it to others, to the fracture, distinct concretions, transparency, &c. employed in settling the remaining species. In these circumstances, when a species of great compass, and really capable of being settled, yet not particularly shewing the connection of its variations to the eye (ii. 31.), presents itself, what can we expect but to see it dissected, and a host arise in its stead, no individual of which possesses either the character of independence, or sufficient marks to distinguish it from the rest.

10. *How these defects must be remedied.*—This procedure should have been inverted; the importance of using any characteristic should have been appreciated according to those species, the arrangement of which can be maintained in conformity with the principles of natural history. It would thence have appeared, that, as those minerals (9.) were capable of no methodical arrangement, whatever natural history system admitted them, must of consequence fall to the ground,—as experience had already shewn of the greater number. On the contrary, to remedy this evil, chemistry has been applied to; the mischief, however, has but become the more virulent on that account. Chemistry has extended its influence to the higher steps of classification; it has brought the principles of the whole science into confusion, and reduced mineralogy itself, to such a state, that it has necessarily ceased to be a portion of natural history.

11. And, besides, chemistry has not been able to perform the service, which in this point was expected from it. On comparing together the analysis of such minerals as admit not natural history arrangement, nothing of a distinctive character is found to result from it. The reason of this lies in the nature of those minerals themselves, which, being either mixtures, or substances decomposed by nature, have sustained alterations, both in the quality and quantity of their component parts. A knowledge of the composition of such bodies, however valuable in itself, is yet unfitted for distinguishing them even empirically.

12. *Continuation of* § 8.—The other source from which the defective settlement of species has originated, is the *want of phy-*

sistorical inquiry concerning the varieties united into one species. The plan of a fundamental inquiry is still scarcely begun to be traced; yet much has already been erected on it. Indeed forms out of all the four series of crystallizations are to be found united under one species,—in several, even in the latest German manuals. No attention has yet been bestowed to obtain an exact settlement of the hardness and specific gravity. But it is self-evident, and confirmed by many examples, that such negligent proceedings as these must needs be followed by *indistinctness* among the species; and that, from the same cause, those species must also be split asunder, is shewn by many of the newest arrangements of our most celebrated mineralogists.

13. *Violation of a universal rule in classification.*—It is a rule in *every* classification, that no one object shall appear in it more than once. Now all mineralogists agree in admitting, that porcelain earth is weathered prismatic felspar. But felspar, though weathered, is still felspar. Porcelain-earth cannot, therefore, be admitted into the mineralogical system as a separate species. The same is also the case with several others; silver-black, copper-black, &c.

14. *Violation of a rule in natural history classification.*—It is a rule in natural history classification, that its objects must be individuals alone, and these only in their state of greatest entireness, of complete formation. Hence it is, that mountain rocks not being individuals in this sense of the word, are excluded from the system. Iron-flint, heliotrope, jasper, tile-ore, clay, tripoli, yellow earth, and many others, are mixtures as truly as granite, though the component particles are undistinguishable, by reason of their smallness. They are partly even mixtures of decomposed minerals. Hence no one of them can be introduced as a particular species into the mineral kingdom. Basalt, claystone, serpentine, &c. are likewise mixtures. Cases may happen, where a mineral can neither be said to be decomposed nor mixed, though it occurs in a state which is usually the consequence of decomposition. This may take place with regard to some porcelain-earths, (those of Aue), to pure clay-earth, and some others. In respect of natural history arrangement, such minerals are to be described as incompletely formed, and regarded as decomposed.

15. *Result of these violations.*—The character of a correctly settled natural history species, will apply to none of the above species admitted by German mineralogists; and if both these and the others, the erroneously and the correctly settled, were in common submitted to a more extensive systematic treatment, collocations would arise from it, in which the properties of a good system must needs be wanting. *A characteristic mark of such a defective system are in the transitions of its species into one another* (ii. 30.); which transitions naturally take place when a determinable species is split into several; as rhomboidal quartz, rhomboidal corundum, and others, in the Wernerian system. Wherever transitions of this kind are met with, it cannot be expected that the system will be useful in any point of view.

16. *The proper mode of treating those minerals which cannot be exhibited as independent species.*—Such are the principal causes of the difference, in regard to its content, between this natural history system of mineralogy and other systems. In one word, *none but real and accurately settled species* have been admitted in the present system. The number of species has, therefore, been considerably diminished. On examining the reasons why many of the species in other systems are not presented in this, it will appear how minerals contained in such species are to be treated in regard to classification. It is necessary in fact, *to unite correctly what has been incorrectly separated.* Thus quartz, iron-flint, hornstone, flint-slate, flint, calcedony, jasper, heliotrope, &c. all join themselves to the species rhomboidal quartz; porcelain-earth appears under the character of decomposed felspar; green-earth as an earthy variety of talc-mica, and so on. We shall afterwards find this to be useful and necessary for the application of our mineralogical system. Indeed a correct settlement of the natural history species is not only the condition, on which alone a system can be consistent with itself, but also the characteristic, without which, it can have no application to practice, or usefulness in general.

17. *On what grounds the estimation of the mineralogical system rests.*—According to the preceding observations, the opinion entertained of the natural history system of mineralogy will depend on two things; *first,* That it be judged *in relation to*

the science for which it serves; and, *secondly*, *With regard to its employment in practice.* If the conceptions included under this system, (of class, order, genus, species), rest on the real and pure foundations of natural history; if they be sufficiently applicable to practice, and have managed what is contained by them in a manner conformable to the rules of natural history; this system will then be correct both in point of form and of content. If it possess those properties, it may differ from others, and correspond to the results of foreign sciences, or not; it will not on that account lose aught of its value for the science to which it belongs. In such attempts as framing this system, it is not permitted to have any thing in view but the particular object, the science, namely, in which one labours,—or ever to lose sight of its stedfast aspect, if one would not labour in vain. The smallest inconsistency will produce disadvantageous consequences that can never be remedied; whereas the unusual and uncouth appearance of such a system, proceeding not from the thing itself, but merely from the current opinion, will speedily disappear. But the question of most importance for estimating the present attempt is yet behind; of what utility does it profess to be, to what is it applicable? A natural system in general proposes two things. *First*, To enable us, with ease, to survey, in an unconstrained connection, the productions of that kingdom which it comprehends; and, *secondly*, To put us in a condition to assign, by means of it, to any given production of Nature, possessing the requisite properties, its place in the system, in order to mark it by the denomination corresponding to that place. The *first* point will be best examined, when the system is considered with regard to *Nature itself*, in other words, when the species, genera, orders, and classes, are actually *brought together*, care being taken that uniformity reign, so far as possible, through all the departments of this collocation. The *second* point depends upon the system of characters. To realise the former of these inquiries, the natural history system of mineralogy is itself subjoined in the first Appendix, and accompanied with some remarks. The system of characters will be examined briefly in our last section.

V. *System of Characters, or Characteristic.*

1. *How the System of Characters arises.*—The foundation of a natural system of mineralogy, depends on what may be called natural historical similarity, *(naturhistorische œhnlichkeit).* Hence in such a system, those objects, which are united by the highest degrees of that similarity, must be found nearest to each other. *After the system has been thus completed,* so far as experience allows, the homologous unities are to be compared together, classes with classes, orders with orders, genera with genera, and species with species, that so we may discover the marks by which they are distinguished.

2. *Nature of the distinguishing marks in the natural and in an artificial system.*—It is clear, that the marks now in question are not, and cannot be, those on which the collocation depends; but that in this respect any mark is suitable, if it serve for a distinction at once certain and universal so far as it goes. In artificial systems, the marks of distinction, being the grounds of the division, are united with their system more closely and essentially.

3. *They afford no visible representation of the object.*—It is farther clear, that the marks of distinction can afford no representation of the objects distinguished. They express not the nature of those objects, but the difference of one from certain others.

4. *Visible representations can be had only of individuals.*—To obtain a representation of the objects themselves, all their marks must be given. Hence it follows, that we are able to obtain what may be called a graphical representation like this of individuals only, or of species, in cases where their individuals are all uniform,—as frequently happens in the inorganic kingdoms of nature; but never of a genus or an order. With regard to these divisions, as well as to species in the mineral kingdom, the multitude and the variety of such marks entirely destroy their distinctness, and render the proposed graphical description impossible.

5. *Difference between the system of characters and description.*—The collection of marks, which serve to distinguish an

order, a genus, a species from one or more others, is named a *character*; and the collection of all those last the *system of characters, or characteristic.* That collection of marks, by the knowledge of which we obtain a complete representation of the object, is named a *description.* The description, and the matters connected with it, are doubtless of great importance for mineralogy, (ii. 56.); but the investigation of them belongs not to this place.

6. *Scias, characterem non constituere genus, sed genus characterem.* Linné, Phil. Bot. § 169.—The system of characters belonging to the natural history system will be estimated in the right point of view, by considering that it is not the character that determines the order, the genus, the species; but the order, the genus, the species, that determine the character. The justness of the settlement of the orders and genera, cannot therefore be discovered from the characters, but only from the natural history properties of the substances comprised in that determination. The system of characters will not, however, be without its use, if, by means of it, the individuals can be easily submitted to natural historical conceptions.

7. *Difficulty of the system of characters in a natural system of Mineralogy.*—In artificial systems, the settlement of the characters is attended with no difficulty; in a natural one with very much. In the natural system of mineralogy, these difficulties manifest themselves chiefly in what regards the orders. When the orders have been collocated in nature, the examination of them clearly displays their difference. But on attempting to denote these differences by marks, and to express them by words, the mineralogist has to strive with an almost boundless multiplicity, which most frequently divests the marks of their universality. This renders it necessary, instead of particular marks, to employ their mutual relations; from which arise some properties not altogether corresponding to the characters.

8. *No chemical helps to it.*—One apparent mode of obviating this difficulty is not unknown to me. It is indeed easy to discover that the genera and species of the natural history orders, agree in *certain chemical relations*; and these might have been admitted among the characters. The latter would, in this case, have been simplified and abbreviated,—and thus have been provided with qualities very desirable for them. In the higher steps

of previous systems, the introduction of chemical characters usually passes without examination; they are placed there only "*to satisfy the understanding*;" therefore, the mode alluded to would have met with acceptance. But what contradicts the principles of a science can never satisfy the understanding; and it is better to endure censure, than, by violating the principles of natural history, to deserve it.

9. *Properties of the characters.*—The characters ought to be as *short* and as uniform as possible. Those of the classes, genera and species, possess the properties just mentioned; but in those of the orders, brevity is not to be attained. However, this defect is no obstacle to its employment in the mean time, and will probably be extenuated afterwards, if the natural historical path in mineralogy be more frequently trodden.

10. *Specimen of the system of characters.*—To avoid becoming prolix, in discussing the various circumstances that concern this matter, it seems advisable to subjoin a specimen of the system of characters. It contains, (1) the characters of the classes; (2) the characters of three contiguous orders belonging to the second class, the *metals*, *pyrites*, and *glances*; (3) the characters of three genera belonging to the second of these orders, *cobalt-pyrites*, *iron-pyrites*, *copper-pyrites*; and (4) the characters of the species belonging to the second of these genera, the *hexaedral*, *prismatic*, and *rhomboidal iron-pyrites* *.

11. *Use.*—*Immediate determination.*—The mode of using this system of characters is the same as in zoology and botany; it needs no farther explanation. Some remarks are, however, necessary upon the condition of those individuals to be settled by means of it. In the characters of species, form, hardness and specific gravity are the principal characteristics; and this is always the case in every species of such a nature as to admit the observation of them. Hence if the settlement of an individual is to be completed, those three characteristics must be capable of being observed in it. Put the case, that, with regard to an individual of the genus Iron-pyrites, the form could not be discovered, though both the hardness and the specific gravity

* Second Appendix.

might be sufficiently determined. In these circumstances, it would be found that this individual belongs to the genus *iron-pyrites*; it might also be hence concluded that its form is not *rhomboidal*; but whether it be hexaedral or prismatic iron-pyrites, would remain undetermined. Any mineral which admits of the preceding three characteristics being observed, is, by means of this system of characters, an object of natural historical determination. This mode of determination is named the *immediate* mode.

12. *Mediate determination.*—But all minerals are not found to allow the preceding three characteristics to be estimated, with the required degree of precision. The form is sometimes not to be discovered, even by applying the means previously explained. (i. 65.) Such individuals, therefore, do not admit an immediate determination; and the mineralogist, in regard to them, finds himself in the same situation as the botanist, when a vegetable that does not flower is presented to him. In this case, the botanist compares the unblossoming plant with one that does blossom; and practice has taught him, how far this comparison must be carried to produce a sure result. The mineralogist proceeds in exactly a similar manner. He determines the individual not capable of immediate determination, *by means of others*, which he forms into a series, placing the given mineral at the end. This mode of determination is named the *mediate.* It depends on the *transitions*, and has already been so frequently applied, that it were superfluous to say more on the subject.

13. *Beginners ought first to engage with the immediate, then with the mediate mode of determination.*—Every natural history system, with its dependencies, is first intended for the tyro in natural history. When a beginner has acquired an acquaintance with the characteristics, and some dexterity in the observation of cleavage; he ought diligently to employ himself in the examination of such minerals as are immediately determinable. Of this kind are those among the solid fossils, in which form (be it either the external or the cleavage form,) hardness and specific gravity are each capable of being estimated,—presupposing, with regard to the first of these characteristics, that the species appear in regular forms. For when this is not the case, as in coals, &c., the form is also at the same time unne-

cessary for determining the species. By this means he will gain an acquaintance with the productions of the mineral kingdom, such as to fit him, in a short time, for applying himself with advantage to those minerals which are only to be determined mediately. A little practice will soon secure to him the requisite experience here also; and now the means are in his hand of extending his acquaintance with the productions of the mineral kingdom, in a fundamental, sure, and instructive manner, to whatever length he may incline. The few minerals which are entirely indeterminable, (and which have been erroneously exalted to the rank of separate species,) he must be content to study *empirically*; and he will have the less reason to complain of this, when he reflects, *that hitherto few mineralogists have been enabled to gain a knowledge of the productions of inorganic nature, in any other way, than by methods, which, though enveloped in much erudition, are strictly empirical.*

(To be concluded in our next Number.)

Art. VII.—*Account of* Mr Robert Bowman *of Irthington, in Cumberland, who has completed his* 115th *year.* By Dr Barnes. In a Letter to Professor Jameson *.

Dear Sir,

I was lately induced by curiosity to visit a remarkable instance of longevity, of which I have drawn up the following brief notice. At my first visit, I was accompanied by two gentlemen, and on making inquiry for old Mr Bowman, the name of the individual alluded to, the person of whom the inquiry was made, very significantly asked, if we meant "the old man of all?" I have since understood, that this is not an uncommon, and certainly a very emphatic, appellation for the old man. You may probably think the following account contains too much of the physician, and too little of the philosopher, for insertion in the

* Read before the Wernerian Natural History Society.

Philosophical Journal. But should you deem it sufficiently interesting for publication, it is at your service. I am, Dear Sir, your obedient servant, THOMAS BARNES, M. D.

CARLISLE, *Sept.* 14. 1820.

MR ROBERT BOWMAN of Irthington, in Cumberland, who is now living, and has completed his 115th year, was born at Bridgewood-Foot, a small farm-house near the river Irthing, about two miles from his present residence. His birth-day is not known, but he believes he was born about Christmas. As some doubts have been entertained with respect to his age, to put it beyond dispute, I have examined the register of his baptism, at the parish-church of Hayton. His name, and place of nativity, as well as the year of his baptism, which was 1705, are very legible; but from his name having been placed at the foot of the page, the month and day are worn out. The baptism immediately preceding his, was on the 23d of September, and the next succeeding on the 28th of October: of course, his must have been between these periods; and if his own account be correct, which the register nearly confirms, he will be 116 years of age at Christmas next. This interesting old man enjoys exceeding good health, and is content and cheerful. He is of the middle stature, and says, when young, he was rather stout, and very strong; that he was fond of wrestling, and considered himself a good one. He joined in the amusements common among young people, and was rather partial to cock-fighting, which he now strongly condemns; but was always sober and regular in his conduct. His parents both died when he was young, but he says that he remembers them very well. He married at the age of 50, and had six sons, all of whom are now living; the oldest is 59 years of age, and the youngest 47. He has a great number of grandchildren, and three great-grandchildren. His wife died at Irthington in the year 1807, at the age of 81. His sons pay him a visit regularly once a year: they appoint a convenient day, and his friends in the village and neighbourhood are invited to meet them. With him this is a day of great rejoicing. His chest is large, and his person well proportioned. Although the hand of Time has at length laid him prostrate, it has not yet made much impression on his constitution. The texture of his body is not loose or emaciated, but firm and in *embonpoint.* His face is not wrinkled or shrivelled, but appears plump, round, and rather florid. His sight is tolerably good: he never used glasses, and can at present see every object around him distinctly. He hears very well, and his taste and smell are very good. His hearing and sense of smell, indeed, are uncommonly acute. His skin is soft and delicate; and his hair, which, in his youth, was of a dark brown colour, is now white. He has had no teeth for upwards of forty years. He sleeps soundly in the night, and also frequently during the day. He has been confined to bed for six years past, yet he can move all his limbs; but he is not able to walk, except with the assistance of two persons. All his limbs are free from complaint, the right hand excepted, the fingers of which are much contracted. This contraction he attributes to an injury he received a few years ago on his shoulder-joint. He always serves himself when taking food, for which purpose he uses his left hand, which is perfectly steady. Between six and seven years ago, he walked to Carlisle, and says he saw the workmen laying the foundation of the new bridge, and returned home on the same day with great ease. Carlisle is about eight miles distant from his residence. He frequently took a staff with him, when walking, but seldom used it; he generally carried it under his arm. Only seven years ago, he actually hedged, reaped corn, made hay, mounted stacks of corn and hay, and assisted in making them; in short, he applied himself to all kinds of farm-labour, and was, to use his own expression, always " a top worker." He first took to his bed during some severe weather in winter, not in consequence of any indisposition, but on account of the coldness of the season. He has preferred his bed since that time, for the superior comfort he derives from it. He resides with one of his sons, upon his own estate, the fruits of his industry. The house which he inhabits is in the farm-house style: his bed is placed in a corner near the kitchen-fire, and he has unremitting attention paid to him by his family. For some time, his bed was in the parlour, but finding that he was at too great a distance from the family, preference was afterwards given to the kitchen. He does not remember ever having been indisposed in his life, excepting twice: the first time was, when very young, and then he had the measles; the second was not many years ago, when he had the hooping-cough. One of his grandchildren slept with him, and they both had the hooping-cough at the same time: he was then upwards of 100 years of age. He has occasionally met with severe accidents, but never had a medical attendant, and does not remember ever having taken a dose of medicine in his life. He was always strong and healthy: if he got wet, while working in the fields, he seldom changed his clothes, and would not unfrequently thrash in the barn, or use some other active employment until they became dry. He never took any tea or coffee, and was never intoxicated in his life but once, and that happened at a wedding. He says his friends deceived him, by putting something stronger than he expected into the liquor he was drinking. He very seldom drank any ale, spirits, or wine, except occasionally at the market, at a wedding, or a funeral, and then only a single glass. He gives two reasons for his not drinking; one is, that he had no particular pleasure in taking intoxicating liquors; the other, he liked his money much better than them. He confesses he was rather avaricious. His common drink is water. His food milk, hasty-pudding, broth, bread, potatoes, an egg, a small piece of animal food, or any thing that the family are taking. His clothing was always plain, but warm and comfortable. His appetite is good, and his bowels are generally moved every second day. He was never regular as to the time of taking his meals or going to sleep. He generally took three meals a day, and dined about mid-day. His breakfast and supper he took when opportunity permitted. Sometimes he omitted a meal, and at other times took four or five in a day, as his appetite prompted, or his occupation allowed him. He went to bed at different times of the night, and sometimes rose at one hour and sometimes at another in the morning. Some nights he was never in bed at all. When he went for lime or coal, which he had often occasion to do, he generally slept in the open air all night. Even at the advanced age of 80, during a part of the summer season, he wrought daily at a peat-moss, a few miles from Irthington, and being there late in the evening with his horse and cart, he would sometimes unyoke the horse, let it go loose upon the common, and take his repose for the night in the cart. This is a good instance of his great industry, as well as of the strength of his constitution: his principal object in remaining all night was, that he might be able to pursue his employment early in the morning. His pulse is 68 in a minute, regular and strong: no ossification of the arteries at the wrist can be discovered. His breathing is natural; and his voice, which is rather strong, appears to have undergone very little change. His mental faculties seem perfect; his memory is excellent as to particular occurrences, but he does not remember dates. He is happy, and appears to enjoy life. He is alive to every thing around him, and acquainted with all the news of the day, at least with such news as country people are generally conversant in, and particularly with any thing that has happened in the village or neighbourhood. When trying his memory, I asked him if he had ever heard of the battle of Waterloo, or of Buonaparte? He answered that he had heard too much of Buonaparte; that he was a bad character, and at best only a coward; as soon as he found himself in danger he ran off. I reminded him that he himself had once done the same thing, having been previously informed that he was employed during the rebellion in 1745 in making trenches around Carlisle, when he made a precipitate retreat: he laughed heartily, and confessed he ran away as soon as he could get; he said he only remained among the soldiers one night. He entered freely into conversation with me, and made many inquiries about Carlisle, and particularly about the Carlisle canal. He said, he remembered the first rebellion in 1715: he was then eight or ten years of age; he heard a great deal about it at the time, and saw several men running away from it. On asking him why he was so late in marrying, he said he never thought much about getting a wife, and how he got one he does not know, but thinks it was by mere accident. When inquiry was made of him if he still entertained any idea of marrying a second time, and if he would not like a young wife, he replied, he would not like a young one; that he thought an elderly one might suit him; but being so very comfortably situated, he was better without one. When I asked him if he ever used tobacco or snuff, he very shrewdly answered, he never wasted his money in that way; he had plenty of ways of getting quit of his money without setting fire to it; and as for spending it in snuff, it was just throwing it away. He seemed healthy and hearty. I have seldom been in the company of any one, either young or old, that enjoyed better spirits. His education has been very limited; but he appears to have profited much by a few plain rules of conduct. His mind has been seldom if ever affected by anxious care, restless ambition, or studious thought. He has led the life of an industrious and laborious farmer. He has been temperate in all his pleasures, for which reason they have been of long duration. He has been regular in his mode of living, which has produced an unusual share of rational enjoyment. He has never indulged to excess in sensual gratifications, nor committed any great irregularity. By him, exercise, temperance, and simplicity of diet, have been considered cardinal virtues:—

> "Multa tulit, fecitque puer, sudavit, et absit,
> Abstinuit Venere et a vino."——Hor.

> "Though I look old, yet I am strong and lusty;
> For in my youth I never did apply
> Hot and rebellious liquors to my blood;
> Nor did I, with unbashful forehead woo
> The means of weakness and debility."——Shakespeare.

I have been particular in describing his habits, dispositions, and appearance, from a conviction, that his habits and dispositions have essentially contributed to prolong his life through a long series of years; and as there is at present very little appearance of decay, he will, in all probability, yet continue to live for many years. Some of his relatives having lived to an extreme old age, it is probable that nature originally conferred upon him a good constitution. One of his brothers died in 1810, aged 99 years; two years ago one of his cousins died aged 95 years, and he has another now living at the age of 85.

There is a remarkable difference between him and the generality of old people: he is cheerful, good-humoured, and easily satisfied; he does not complain of any unpleasant change that has taken place in any thing around him, nor of the habits or manners of the people. This, I think, can in no way be accounted for, except from the perfect state of his senses and mental faculties. The degeneracy of the times, and the disagreeable changes of which many old people bitterly complain, are not so much to be attributed to any change in the objects around them, as to themselves: their senses and faculties being impaired, the same objects cease to make their former agreeable impressions.

Art. VIII.—*Observations on the Florida or Gulf Stream.*

ONE of the most singular phenomena in hydrography, is that perpetual current of water flowing out of the Gulf of Mexico, along the coast of Florida, into the Northern Atlantic, commonly, among seamen, called the Florida or Gulf Stream. Various attempts have been made to account for this celebrated current, and as it is an object of general interest in natural history, we conceive it will gratify some of our readers to present them with a concise view of those causes which appear the most rational.

It is known, that the tides in the ocean are produced by the combined actions of the sun and moon, causing the waters, in general, when their course is not obstructed by continents, islands, &c., to take a westerly direction. The winds in the tropical climates, from nearly the same cause, blow generally the same way. It is also observed by navigators, that when a wind blows for any length of time, in a given direction, the waters of the sea move in the same direction, forming a current, at least at the surface, more or less strong, according to circumstances, setting in that direction.

The whole body of the waters of the Atlantic, then, must have a general tendency to move from the coasts of Europe and Africa, towards the shores of America, which must be modified in its effects, according to the different conformations of the coasts and other combining circumstances. If we examine the coast of North America, we shall find, that its direction is nearly that of the meridian, or north and south, at least from about New York to Cape Sable in East Florida. Therefore, the mass of waters coming from the east, will strike it nearly at right angles, which, after high water, will gradually retire into the ocean towards the east, without producing any considerable current along the coast, or any accumulation in a particular place, as it otherwise would have done, if that coast had been more oblique to the direction of the tide, though the Bahama islands, and shallows, must prove a considerable obstruction to the flood-tide setting directly westerly, near Florida, and will have some tendency to cause it to flow more to the north.

If we now turn our attention to the northern coast of South

America, we shall find that it follows nearly the direction of a parallel of latitude, or east and west, and of course, very oblique to the tide coming from the east; and, therefore, it is natural to suppose, that a current will be produced, setting westward, from Cape St Roque, along the shores of Guinea, Cumana, Terra Firma, the Musquito Shore, &c., towards Cape Catouche in Yucatan. This, indeed, is verified by observation, for it is found, that the flood-tide combined with a current, runs along these coasts, generally at about the rate of two or three miles an hour. This current setting along the Caribbean Sea, will enter the Gulf of Mexico between Cape Antonio, in Cuba, and Cape Catouche, in Yucatan, and must, of course, raise the waters of that Gulf, to a considerable height above the general level of the ocean. A part of these waters, after the time of high water, will fall back into the Caribbean Sea; and there actually has been observed a current off Cape Antonio, setting eastward along the south coast of Cuba. Indeed it has been asserted, by Captain Manderson of the Royal Navy, in his Observations on the Gulf Stream, that the waters about Cape Antonio, "move sometimes one way, sometimes another, and are sometimes stationary," which may be expected, according as it is flood-tide, ebb-tide, or high water.

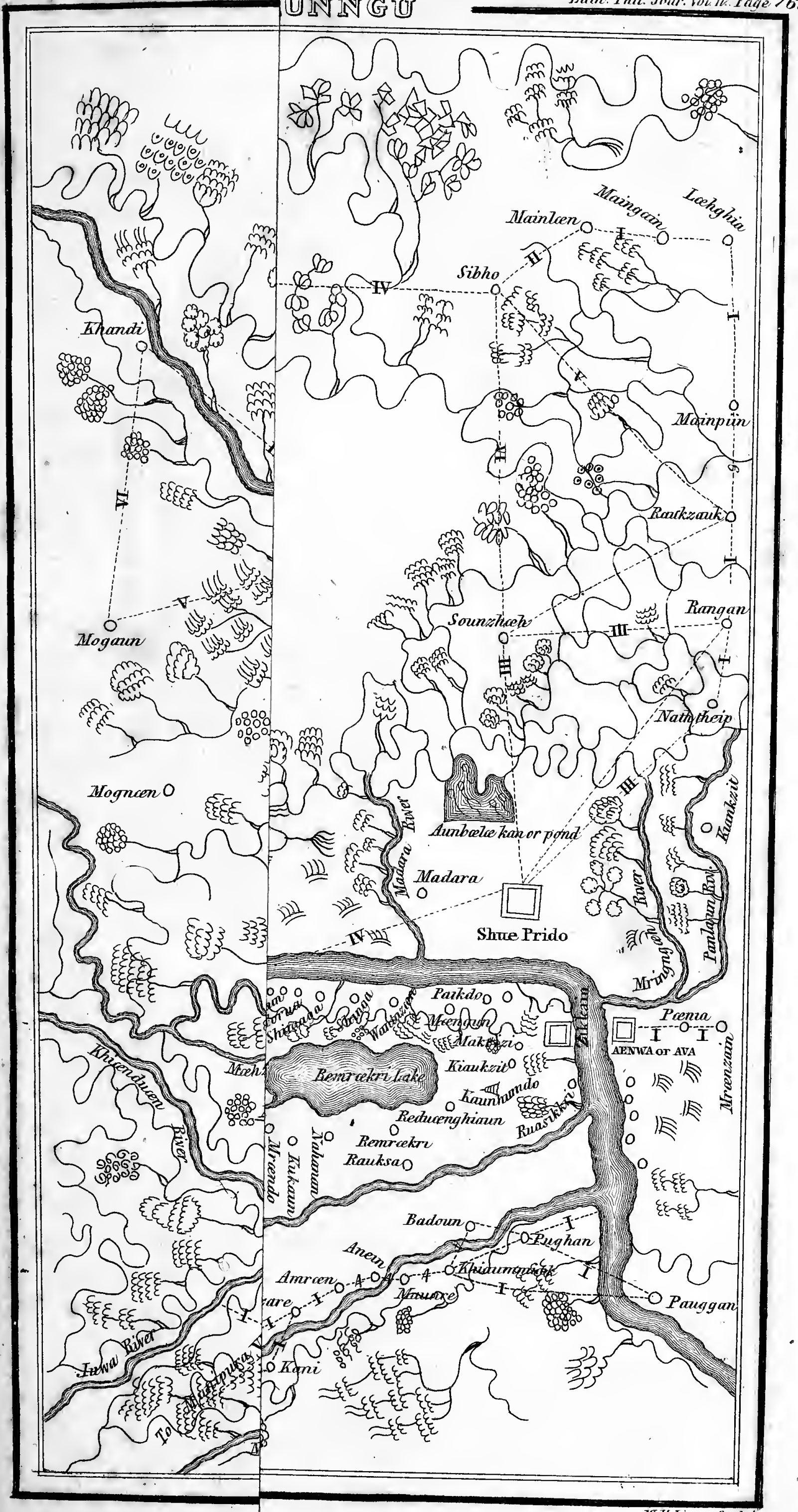
From what we have already advanced, it is clear that the waters between Cuba and Yucatan, must be higher than those between Cuba and Florida; and, therefore, the mass of waters carried into the Gulf of Mexico, in the manner already mentioned, must flow out between Cuba and East Florida. If we also take into consideration the number of great rivers, and among them the Missisippi, itself like a sea, that falls into the Gulf of Mexico, which is, comparatively speaking, small, their waters must endeavour to extend themselves over a portion of sea greater than that gulf; and since, from the accumulation of water coming from the Caribbean Sea, depending on causes already pointed out, the waters of the Missisippi, and other rivers, falling into the Gulf of Mexico from the west and north, cannot extend themselves over that sea towards the south, they must flow along its northern shore towards the east. That the waters of great rivers do flow to a considerable distance in the ocean, can be easily proved. In Columbus's first voyage to America, he found his vessel in fresh water, at the mouth of the Orinoco, before he discovered land, whence he inferred, he was near some great continent, which alone could produce such a stream. In Macleod's voyage to China, a stream of fresh water was found at a considerable distance from the shores of Java, and the British fleet, which blockaded Toulon, occasionally took in fresh water at the mouth of the Rhone, at a considerable distance from land. Hence, then, it is clear, that the streams of large rivers flow a considerable way into the ocean. The Missisippi, and other large rivers which fall into the Gulf of Mexico, must therefore, in some direction or other do the same. But since a current of water flows generally into the Gulf of Mexico, between Yucatan and Cuba, the waters of the Missisippi cannot flow out in that direction; they must therefore, with more or less volocity, flow out between Cuba and Florida. This, combining with the superabundant waters of the ocean collected in the gulf, flowing round between Cuba and Cape Sable in Florida, is, by the north-west shores of Cuba, the Bahama Isles, and banks, turned round the eastern shores of East Florida, and must set northward along the east coast of America, with considerable velocity, constituting what is called the Florida or Gulf Stream. This conclusion is verified by observation; for the waters in the Gulf Stream, in the greater part of its course to the north of the Bahama Islands, are found, by the thermometer, to be warmer than those of the seas immediately bordering on it, whence they must come from a warmer climate, and, when chemically examined, to possess a less degree of saltness, and therefore must consist chiefly of fresh water. Hence, from these two causes, namely, the *current* formed by the flood-tide setting in between Cuba and Yucatan, and the *fresh water* from the Missisippi, and other large rivers, falling into the Gulf of Mexico, combined and modified in the manner we have described, and not either of them separately, as has been sometimes affirmed, making its escape northward, along the eastern coast of America, we think, it will evidently appear, is derived the true cause of the Gulf Stream. Hence, too, the circular motion of the waters in the northern Atlantic, and other phenomena, attempted to be established by Humboldt, will receive a satisfactory solution.

EDINBURGH, *September* 1820. NAUTICUS.

Art. IX.—*Account of a Map of the country north from Ava.* By Francis Hamilton, M. D. F. R. S. & F. A. S. Lond. & Edin. With a Map. Communicated by the Author.

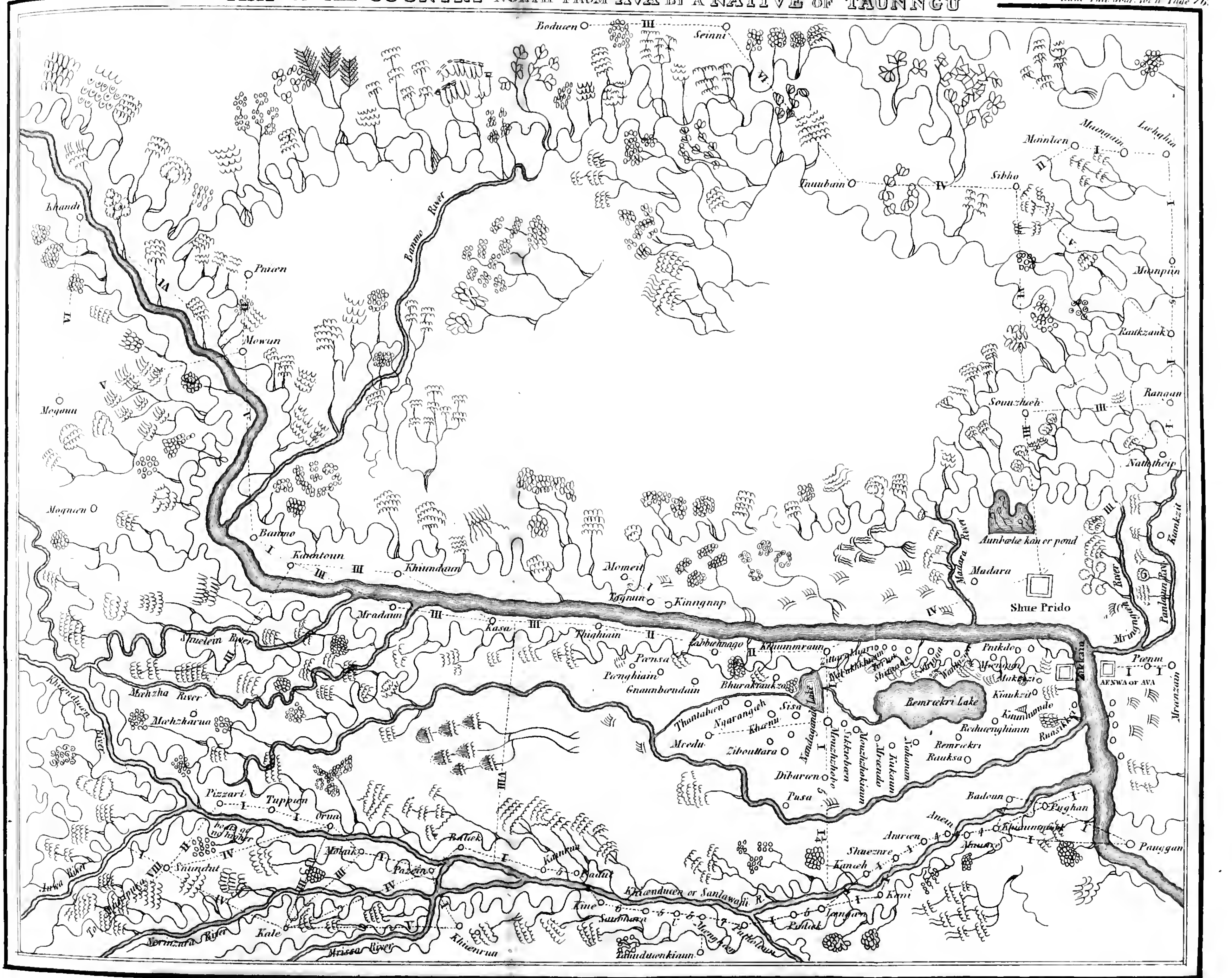
During a visit of ceremony from one of the secretaries of state (Zaredogri) to the British resident, while we were at Amarapura, I had an opportunity of forming an acquaintance with a relation of that officer, who was a native of Taunu. This person, a mild and well behaved man, afterwards visited me to obtain information respecting Bengal, and in return gave me several draughts of the country. He was not so intelligent and quick as the slave who gave me the general map already published, (*Edin. Phil. Jour.* No. III.); but he was not so timid, having powerful connections; and, after I began to be satisfied with his performances, did not think it necessary to expunge his writings. In this, however, he used many contractions, so that, without the assistance of the person I found at Calcutta, I should have been unable to make out the spelling of many names at full length.

This person's first attempts, as might be expected, were very rude. He began at a given place, say his native city, and, going on in a certain direction, he laid down the places occurring, until his paper afforded no more room. He then twisted round his line, until he completed the route with which he had commenced. Then he returned to the first point, and commencing with a second route, proceeded in the same manner, and continued so on until he traced the whole of what he intended. The remote parts were thus distorted in a most extraordinary degree. After some pains, however, he improved much, and produced the map, now published on a reduced scale. (See Plate II.) Although this is very superior to his first attempts, it is not quite free from the errors into which he at first fell. The rivers are marked by double lines as in our maps. Mountains are represented by waved single lines, surmounted by rude delineations of trees, good deal in the style of Chinese procelain; and I have reason to think, that, like the Chinese artists, he has given to each kind a sort of appropriate form, although the resemblance is by no means striking to a botanist, and I am not prepared to point out



W. H. Lizars Sculp^t.

MAP OF THE COUNTRY NORTH FROM AVA BY A NATIVE OF TAUNNGU



Edinburgh, Published by A. Constable & Co. 1820
W H Lizars Sculpt

the kinds which he meant to represent, as being the most common in each forest. Some forms were, however, pointed out, especially one representing the tea-tree, which grows spontaneously in many parts of the peninsula.

The distances in this map are marked, partly in days journeys, partly in leagues, (dain,) the league of the Mranmas being 1000 poles of 11 feet 8 inches, or nearly $2\frac{1}{5}$ British miles; and the day's journey is reckoned 10 leagues, road distance. Now, the author gives 18 days' journey from Amarapura to Banmo, Bhanmo, or Panmo, the Bampoo of Mr Arrowsmith, the direct distance, according to this geographer, being nearly 128 geographic miles, so that the day's journey on great distances, in this map, can only be reckoned about $7\frac{1}{9}$ geographic miles in a direct line. How many leagues or miles are actually travelled each day, I cannot say; but in Western India, as well as in the Eastern Peninsula, I have very generally found, that distances estimated by days' journeys, turn out much less than what is usually stated that a man should travel in the given time. We have seen, (*Edin. Phil. Jour.* No. V. p. 36.) that in China, where the roads are tolerable, the ambassadors from Ava made long journeys, at the rate of about $16\frac{1}{2}$ miles a-day, in a direct line of the whole distance; and it is from this probable, that the actual road distance travelled each day, might be 10 dain, or 22 miles; and such may be the case in the parts of their own country that are level and clear; but in journeys of a considerable length, through mountainous forests, no such allowance can be made, and the actual distance will seldom be much more than half as much. In the map now published, as well as in the others which I have still by me, the distances marked with Roman numbers, denote days' journeys, those marked with cyphers, denote leagues of $2\frac{1}{5}$ British miles. It will be evident, on the slightest examination, that in laying down the places on the map, little attention is paid to the respective distances.

Having now given a general account of the accompanying map, I shall proceed to examine into particulars, beginning with the north. In the first place, we may observe, that the author commencing at Amarapura, which, like other courtiers, he calls

Shue Prido, when he had proceeded north with the Erawadi to Banmo and Mogaun, found himself straitened for room, and, in order to obtain space for introducing Khandi, turned the river obliquely to the right, so that instead of bringing it straight south from Tchoudsong to Banmo, it appears as if coming from the north-east; and the principal branch, formed by the Kenpou, is altogether omitted, unless we suppose, what I imagine to be the case, that, for want of room, the compiler has put Khandi in the place where Paiænduæn should have been, and has transferred the latter to the opposite side of the Erawadi, where Wænmo really stands, there being no doubt, that the Zabua of Banmo placed his own town right. At the same time, the author of the accompanying map, has given the name of Mowun, a Chinese city, to Kakio, another town belonging to the same chief. With these alterations, the distances here given may be of great use; and we shall have Kakio, called here Mowun, 5 days' journey, or 42 miles north from Banmo, exactly as the Ambassador's map (*Edin. Phil. Journ.* No. V.) places it; and the real Paiænduæn, called in this map Khandi, 6 days, or 52 miles farther north; while Mogaun is 42 miles north-west from Kakio, and 52 south-west from Paiænduæn, and the real Khandi is in fact omitted, together with the northern forks of the Erawadi.

In consequence of the upper part of the Erawadi having been turned to the north-east, in place of continuing north, the river of Banmo or Santa is brought from the south-east, in place of the north-east, and its source is placed in the Shanwa country, near Boduæn, instead of in China. Boduæn, in fact, at one time was held by the Chinese, and it was in its vicinity that the decisive engagement took place between the Mranmas and Chinese, in the reign of Zænbrushæn, who governed Ava from 1769 until 1781. It is said, that on this occasion 60,000 captives put an end to the Chinese hopes of conquest, and gave the Mranmas possession of the valuable mines of Boduæn. I have little doubt, that Boduæn is the place five days' journey north from Mohang Leng, once the capital of the Northern Laos, where, as mentioned in the Modern Universal History, (vol. vii. p. 153. and 154.), there are mines of gold, silver, and copper, wrought by Chinese. Now, in the accompanying map, we have Sibho, a Shanwa city, seven days journey, or about 50 G. miles east from Amarapura; and we have Boduæn, thirteen days' journey, or 92 G. miles NN.E. from Sibho; this would bring Boduæn 54 G. miles S.E. from Banmo, and 115 N.E. by N. from Amarapura. But a Muhammedan, who was in the battle between the Mranmas and Chinese, and with whom I met at Calcutta, told me, that Boduæn was six days' journey from Banmo, and fifteen from Amarapura, which, supposing the accompanying map to be right, would require the day's journey between Banmo and Boduæn to be 9 G. miles, and between Amarapura and Boduæn to be $7\frac{2}{3}$ miles, in place of $7\frac{1}{9}$ miles, assumed as the day's journey in this map,—a difference of little importance in considering such rude materials. When we were at Ava, Boduæn was governed by a Mranma officer, with the rank of Mrosagri, having under him a custom-house, and a small military guard. The inhabitants are Shan, the place probably having been originally a portion of the Lowa Shan, or Northern Laos, and seems to have on its east the country of the Kakhiæn, who form the greater part of the population along the eastern frontier of Yunnan, partly independent, and partly in the territory belonging to the Prince (Zabua) of Banmo, and who, with the Wild Lowas, are probably included by the Chinese under the general name Lolo, a people which, in the maps of Du Halde, occupies a large portion of the south-west parts of Yunnan.

In the accompanying map, the Shue Li, mentioned by the Ambassador to China as entering the left bank of the Erawadi above Miadaun, is altogether omitted, and Mradaun (evidently another orthography for Miadaun) and Shue Li are transferred to the other side of the great river, while Khiundaun, placed by the Ambassador on the right of the Erawadi, is in the accompanying map brought to the left, to occupy the room of Miadaun. Which authority is preferable, I cannot say; for although another map by the slave formerly mentioned, (*Edin. Phil. Journ.* No. III.), places Miadaun on the right, and Khiundaun on the left of the Erawadi, yet there is no doubt that a river at least as large as the Thames enters from the left, it being that which passes to the eastward of Tengye and Tienma, in the maps of China.

All the three authorities mentioned above, the native of Taunu, the slave, and the Ambassador, agree, however, in making two rivers join this part of the Erawadi from the right. In the accompanying map, and that of the Ambassador, (*Edin. Phil. Journ.* No. V.) the lower one is called Mæzha, while in that of the slave it is called Shue Li; but this name is transferred by the accompanying map to the upper of the two, which in the Ambassador's map is called the Kokuæ, and in the slave's the Mæzha. Here I must give the preference to the Ambassador's authority; and I am inclined to think, from verbal information which I received, that there is no Shue Li entering the Erawadi on the right, but that the river, the two branches of which are often called Mæzha and Kokuæ, is often called the Shue Lein or Gold-dust river, from its sand containing that substance. It must, indeed, be observed, that in the accompanying map, there is an appearance of these two rivers being branches from the same source,—a circumstance adopted by Mr Dalrymple, and not improbable. They seem to run through a very mountainous country, without any place of consequence on their banks, Mæzha being only a village (Rua). They seem to spring from the east side of a chain of hills, which, rising opposite to old Ava, and producing there white statuary marble, of the finest quality, run nearly north for a long way, at first near the Erawadi, but afterwards more remote from its right bank, separating the countries of the Kasi Shan and Shanwa or Mrelap Shan, at least according to the division that was established when I was in the country; but nothing can be more liable to change than the divisions of territory under such a government.

The Kasi Shan I consider as those in Asam called Nora. They are governed by a collateral branch of the Asam Rajas, and occupy the upper parts of the Khiænduæn, between the proper country of the Mranmas on the south, and Asam on the north, and between Kasi on the west, and the Mrelap Shan on the east. At Amarapura, I saw several of this people, who spoke a dialect that I could not distinguish from that of Siam. They called themselves Tailung; by the Kasi of Manipur they are called Moitay Kabo, to distinguish them from the Mrelap Shan, whom the Moitay or Kasi of Manipur call Awakabo. Some of them with whom I conversed, alleged that the Erawadi is their proper boundary, and that of course the Mogaun of the Mranmas, which they call Mungun, with its dependencies Paiænduæn and Khandi, belonged to them; but when I was in the country, their prince, called a Zabua by the Mranmas, resided at a town named Saundut; and Mogaun was held by a chief with the same title, who was included by the government of Ava among the Shanwas. I have, however, strong reasons to think, from verbal information received through the slave to the heir-apparent, that all the Shan, on both banks of the Erawadi, as well as of the Khiænduæn, were originally of the same race, calling themselves Tailung, and differing somewhat from the Shanwas, who inhabit the country between the proper territory of the Mranmas and the Saluæn river. The policy of the present dynasty in Ava has been to separate both nations into a number of petty principalities, governed by hereditary chiefs, descended mostly from their ancient princes, but now quite unconnected, and often opposed in personal interests.

The accompanying map does not contain so full a view of the country on the upper part of the Khiænduæn, as the general one published in Number III. of this Journal, as it does not extend to the place where this river is formed by the union of the Uru and Naindain rivers, which probably arise from the hills bounding Asam on the south, in about 27° of N. Lat. The Khiænduæn receives from the right a river named Narinzara, the mouth of which, according to this map, is 11 days journey from that of the Khiænduæn, which, at the same rate as the days journeys on the Erawadi, according to this map, would give a distance of 78 G. miles in a direct line. From the mouth of the Narinzara to Saundut, the capital of the Tailung or Kasi Shan, this authority makes almost eight days journey, say 54 miles; and from thence to Munipura, the capital of Kasi, is eight days journey, which agrees very well with the situation commonly given to that city, the course of the Khiænduæn and Mukhiaun being placed nearer the Erawadi than is done in Mr Arrowsmith's map of Asia, which makes the space between the two rivers too wide; as, according to the accompanying map, the distance between the mouth of the Narinzara and Erawadi is only eight days journey, or about 57 G. miles in a direct line; and lower down, the distance is still less being only half as much at Mouzhzhobo. On the left of the Khiænduæn, the country of the Tailung or Kasi Shan does not extend so far to the south as on the right. In the general map by the slave, the lowest town of this nation on the left bank is called Kasa, which is not mentioned in the accompanying map; but I am inclined to think, that Balæk, $13\frac{1}{2}$ days journey, or about 95 G. miles up the river, is the uppermost Mranma town in that quarter.

The proper territory of the Mranmas extends but a very short way to the west of the Khiænduæn, having, according to this map, for its boundary a low chain of hills, which commences at Pukhan, and extends all the way to the Kasi country. In the accompanying map, only two places beyond this chain are mentioned. The one is a village called Khiæn, probably from its being inhabited by people of the Khiæn tribe. It is situated where the Narinzara receives a tributary stream called the Mrissa. This, being one day's journey from the Khiænduæn, may be considered as not more than 22 British miles road-distance from thence, leaving room only for a very small ridge, which separates the country of Io from that of the Mranmas; nor can this be considered as a branch of the mountains extending from Cape Negrais, as represented in the general map of the slave. Another low ridge, which is called Danghii, extends parallel to the Erawadi opposite to Pougan, commencing with a *dolphin head* a little below that city, and seems to join the former about two days journey above the mouth of the Khiænduæn. The part of it which I saw is of very moderate height, as from Pougem I could see over it the mountains of Khiæn; but it is exceedingly naked and barren. Between this chain, called Danghii, and the mountains of the Khiæn, is a river called Jowa, which, where it enters the Erawadi, has a very wide sandy channel, and in the rainy season contains much water, nor does it ever become altogether dry; but it is said to be too rapid for navigation, and, when I saw it, on the 5th of November, the rainy season being then over, its stream was about 30 yards wide. It is said to spring from the Khiæn mountains; but in the accompanying map, from above Padæk, almost seven days journey, or 50 G. miles from the mouth of the Khiænduæn, this last mentioned river seems to send off a branch, which passes through the chain of hills, and I suspect is connected with the Jowa; but this has another source in the Khiæn mountains.

About 56 G. miles in a direct line from the mouth of the Khiænduæn, the accompanying map places a town named Mænghæn, which some other authorities place nearer the Narinzara; but the authority of this map is here probably the best. West from Mænghæn, and beyond the low hills one day's journey, or perhaps 22 B. miles road-distance, is the other town already alluded to, and called Taunduængiaun. In the general map this is reckoned the chief town of one of the governments of which the Io country consists; but I am inclined to think that this is a mistake, as I intend to explain in giving an account of another map. I consider it, in fact, as the chief town of a people called Aengiin, who inhabit the country on the west side of the Khiænduæn, south from Kasi, and on a route leading from Amarapura to Manipura. They are represented as a very rude fierce tribe; but cultivate much rice, and their chief was said to have a representative at the Court of Ava when we were there.

The Mranma country, between the Khiænduæn and Erawadi, according to this map, extends on the latter to Zabbæhnago, about 46 G. miles north from Amarapura, and considerably farther on the Khiænduæn. It is finely watered by two reservoirs, constructed to collect the rain-water brought by the Mu torrent. The southern of these reservoirs is called Remiækkri, and in this map makes the largest figure, because the northern reservoir, called Nandagun, is represented merely by a double line bounding the space between its western limits and the hills on the bank of the Erawadi, to which in the rainy season it probably extends. It seems, however, to be the greatest work of the two, and according to this map extends from near Mouzhzhobo, once the capital of the empire, to Mrædu, a distance of two days journey. Other authorities make the distance still greater.

The country of the Mranmas, on the left of the Erawadi, has on the east a mountainous region, which in the accompanying map reaches the river, above Tagaun, two days journey above Zabbæhnago, which, in the general map by the slave, is reckoned the uppermost Mranma town on that bank of the Erawadi; for, although the Ambassador's map places this town on the left, both the slave in the general map, and the native of Taunu, agree to place it on the right. This difference, however, is not an error in either party, as I understood that the town is really on the right; but the customhouse, which is most frequented by travellers passing on the river, stands on the left bank. Indeed even lower down I had occasion to observe, that notwithstanding the great size of the Erawadi, part of one town stood on each side of this noble river. Unfortunately, for reasons formerly mentioned (N° III.), I did not obtain the names of the six towns between Zabbæhnago and Bhanmo in the general map of the slave; but as the same number exactly occurs in the Ambassador's route (N° V.), we may conclude that the same towns are meant, and therefore that the first Shanwa town on this route is Kiangnap, although it is on the west side of this mountainous tract, which the slave states as the boundary between the Mranma and Shan nations; but then he makes the mountains descend to the Erawadi at Zabbæhnago. The accompanying map, however, seems here more correct than the general one drawn by the slave, and represents the hills east from Amarapura, not as a narrow ridge, separating the two nations, but as a mountainous region, among which are many valleys occupied by the Mrelap Shan, who at Kiangnap extend to the Erawadi at or near the termination of the hilly region.

Between the capital and Kiangnap, in the accompanying map, is laid down a small river, not noticed in either of the two authorities already published. It descends from the mountainous region of the Shanwas, and falls into the Erawadi, passing on the north side of the city called Maddara. East from this town and the present capital, and near the hills, is an artificial pond (kan) of great extent, and called Aunbænlæ, or the pond of Nelumbium, the figures in the map being drawn in imitation of the leaves of this splendid vegetable.

At the old city of Ava, or more properly Aenwa, the Erawadi receives another stream called Mringngæh, or the Little River, in contradistinction to the Erawadi or Great River. Various canals between the two surround the city, which is most nobly and conveniently situated, at the junction, in a fertile and highly beautiful country, containing immense rivers, extended plains, lofty mountains, projecting rocks, and abundant materials for the most ornamented architecture. The climate, however, of the Mranma territory is not very favourable; the rains being seldom sufficiently abundant; so that without artificial irrigation, all the neighbouring countries are more productive of grain. A though not reckoned so salubrious as Rangoun, Ava is by means unhealthy. The Mringngæh, in the accompanying map appears as if it sprung from the face of the hills east from Ava but, in fact, as we learn from the general map of the slave, it passes a great way through the mountainous country of the Shanwas, rising on the frontier of China, and probably passes near Boduæn, from whence running south, through a populous valley, to the parallel of Ava, it there turns west to join the Erawadi; nor, on account of its being called the Little River, are we to conceive, that its size is like the streams of Britain, the largest of which, among the Mranmas, would be only considered as a Khiaun, and would not receive the title of Mrit. Its mouth, which alone I saw, was very wide, although no doubt inferior to the Erawadi, and it is only in comparison with this, that it has obtained the denomination Little.

Some way before the Mringngæh joins the Erawadi, it receives two branches, one only of which, the Panlaun, is mentioned in the accompanying Map; and as it comes from about the south-west, the paper did not admit of its being laid right down. The compiler, therefore, has been under the necessity of making its course east and west, and therefore of bringing all the neighbouring cities, such as Puefla and Læhghia, much too near Sibho. Neither of the branches of the Mringngæh admit of navigation; but canals dug from them irrigate a large extent of country, at present, I believe, the most productive territory of the empire.

Owing to the Panlaun having been too much bent to the north, and the Banmo too much to the south, the whole of the Mrelap Shan country to the east of the Erawadi is in this Map much distorted; but the distances will serve to give the real situations. It must be observed, that to the east of the seven cities held by Shanwa chiefs on the Erawadi, there is a large space occupied by woods and mountains, in which no cities are laid down on any authority which I possess; and the first towns to which we come in this direction are Boduæn, Seinni, Taunbain, Sibho, and Sounzha, all towns, I think, in the valley of the Mringngæh. This mountainous space, I have no doubt, is the Pahimapan of the Modern Universal History (vol. vii. p. 153.) The only place in this extensive space laid down in the accompanying Map, is Momeit, perhaps twenty British miles road distance from Kiangnap, and twelve from Tagaun; and near this are the principal *Ruby Mines* in the empire, or I believe in the world; but to this I shall have another occasion to return.

Beyond these eastern towns of the Mrelap Shan, mentioned in the last paragraph, this Map does not extend, although the territory dependent on them reaches to the river Saluæn, and, according to the divisions of the empire which existed in 1795, extended in some parts beyond that river. It is in the space between Sibho, Taunbain, Seinni, and the Saluæn, that there is an extensive region containing forests or thickets of the tea-tree, which the Mranmas call Lapæk, and the Portuguese of India name Champok (See *Modern Universal History*, vol. vii. p. 129.) These woods are inhabited by a tribe of Shan called Palaun, by whom the tea-leaves, in place of being dried for infusion, as is done by the Chinese and Japanese, are pickled for being chewed, and the quantity of this pickle consumed all over the empire is very great.

It is not to be conceived, that the greater part of the mountainous and woody regions in the Eastern Peninsula of India are wastes; on the contrary, in general they abound in inhabitants, the rude aborigines of the country, and are often more productive than the cleared plains, as the people are more addicted to agriculture than the more civilised races, who chiefly occupy towns, and live mostly by manufactures, fishing, and commerce, exchanging their commodities with the rude tribes for grain. The rude tribes, on the contrary, are diligent cultivators, clearing the forests in succession after long fallows, and thus procuring very plentiful crops from the lands enriched by rotten foliage and rest. These people have no towns, but live under their own native chiefs, protected in a considerable degree by their woods and mountains from the oppression of the mushroom despots, under whom the more civilised races usually groan.

Art. X.—*Continental Observations on the Solar Eclipse of the 7th September* 1820, *with the Times of Conjunction, calculated from* Burckhardt's *Elements*. By M. Charles Rumker, Director of the Nautical Academy at Hamburgh. In a Letter to Dr Brewster.

Dear Sir,

Having collected a great number of observations of the solar eclipse of the 7th September, I have calculated from them the true time of conjunction of the Sun and Moon, and have taken the liberty of sending you them for insertion in the Edinburgh Philosophical Journal. None of the observations made in England have yet reached me. The calculations are founded on the Elements of Burkhardt, which the collection of a greater number of observations will enable me to correct. I am, Sir, yours, &c.

Hamburgh, *7th Nov.* 1820. C. Rumker.

1. Bologna.

Lat. 44° 30′ 12″; E. Long. 45′ 26″ in time.

Observed beginning of the Eclipse,	1^h	35′	31″.	32	Mean Time.
Time of conjunction calculated from it,	2^h	35	30	51	
End of the Ring, -	3	05	00	32	
Time of conjunction calculated from it,	2	35	20	42	

2. Genoa.

Lat. 44° 24′ 34″; E. Long. 35′ 42″.5 in time.

Observed end of the Eclipse, -	4^h	11′	59″	Mean Time.
Time of conjunction calculated from it,	2	25	34.77	

3. Bremen.

Lat. 53° 04′ 38″; E. Long. 35′ 13″ in time.

Beginning of the Ring, -	2^h	29′	24″	Mean Time.
Time of conjunction calculated from it,	2	25	21.1	
End of the Ring, - -	2	34	41	
Time of conjunction calculated from it,	2	24	55.5	
End of the Eclipse, - -	3	52	13	
Time of conjunction calculated from it,	2	25	04.8	

4. GOTTINGEN.

LAT. 51° 31′ 56″; E. LONG. 39′ 47″ in time.

Beginning of the Ring,	-	2h 38′ 11″.1 Mean Time.
Time of conjunction calculated from it,		2 29 53.3
End of the Ring,	-	2 43 16.25
Time of conjunction calculated from it,		2 29 20.1
End of the Eclipse,	-	4 00 44
Time of conjunction calculated from it,		2 29 37.4

5. NIEUSTEDTEN.

LAT. 53° 33′ 10″; E. LONG. 39′ 25″ in time.

Beginning of the Eclipse,	-	1h 10′ 38″.5 Mean Time.
Time of conjunction calculated from it,		2 29 30.5

6. COPENHAGEN.

LAT. 55° 40′ 55″; E. LONG. 50′ 20″ in time.

Beginning of the Eclipse,	-	1h 21′ 22″.2 Mean Time.
Time of conjunction calculated from it,		2 40 32.2
End of the Eclipse,	-	4 03 22.1
Time of conjunction calculated from it,		2 40 11.5

7. BOGENHAUSEN.

LAT. 48° 8′ 49″; E. LONG. 46′ 26″ in time.

Beginning of the Ring,	-	2h 53′ 23″ Mean Time.
Time of conjunction calculated from it,		2 36 27

8. MANHEIM.

LAT. 49° 29′ 18″; E. LONG. 35′ 53″ in time.

Beginning of the Ring,	-	2h 35′ 25′.5 Mean Time.
Time of conjunction calculated from it,		2 23 49
End of the Ring,	-	2 40 21.6
Time of conjunction calculated from it,		2 23 44.4
End of the Eclipse,	-	3 58 34.5
Time of conjunction calculated from it,		2 23 41.4

9. HAMBURGH.

LAT. 53° 33′ 08″; E. LONG. 39′ 57″ in time.

End of the Eclipse,	-	3h 56′ 27″.9 Mean Time.
Time of conjunction calculated from it,		2 29 47.5

10. Berlin.

Lat. 52° 31′ 15″; E. Long. 53′ 31″.5 in time.

End of the Eclipse, -	4^h	13′	44″.7	Mean Time.
Time of conjunction calculated from it,	2	43	16.4	

11. Cuxhaven.

Lat. 53° 52′ 40″; E. Long. 34′ 51″ in time.

Beginning of the Eclipse, -	1^h	4′	10″.4	Mean Time.
Time of conjunction calculated from it,	2	24	55.5	
Beginning of the Ring, -	2	27	25	
Time of conjunction calculated from it,	2	24	57.6	
End of the Ring, -	2	32	27.9	
Time of conjunction calculated from it,	2	24	33.3	
End of the Eclipse, -	3	49	58.7	
Time of conjunction calculated from it,	2	24	41.1	

Art. XI.—*On the Volcanoes of Auvergne.* By Charles Daubeny, M.D. M.G.S. In a Letter to Professor Jameson. (Continued from Vol. III. p. 367.)

Time will not allow of our particularising any other of the recent volcanoes, for there are several which possess claims to our notice. The traveller in particular will not fail to visit the Puy Pariou, remarkable for the regularity of its crater, no less than its depth, which, according to M. Ramond, exceeds 250 feet; the Puy de la Vache, which we briefly noticed as having supplied the current of lava that obstructs the Lake Aidal; and others of scarcely inferior interest. Omitting those, however, as inconsistent with the limits marked out for the present paper, we shall proceed to consider another description of rocks found in the same neighbourhood, the nature and origin of which appear to be somewhat more problematical.

The department of which Clermont is the capital, has received its name from a mountain, which, as the highest in the province, and occurring in some degree detached from the rest, has acquired more importance than it might in other situations have obtained, although its altitude is considerable, exceeding considerably 4000 feet. The Puy de Dôme is of a conical form, and remarkable for the distinctness of its outline, rising abruptly from the midst of a sort of amphitheatre of volcanic rocks, which it considerably overtops, but which, by a little stretch of the imagination, may be supposed to have constituted the crater from which this central mass was projected. However this may be, the mineralogical characters of the mountain are such as differ entirely from those of the hills on either side of it. The Puy de Dôme seems to consist almost entirely of a rock with a felspar base, having crystals of glassy felspar and of augite disseminated through it, frequently containing plates of mica, and more rarely fragments of quartz. In some cases, the different ingredients are so intimately blended, that the aggregate might be mistaken for a whitish sandstone until carefully examined. The most extraordinary circumstance is, that the rock in question is confined to this hill, and two or three in its immediate vicinity, which, though they all present some modifications of aspect, still possess sufficient of a common character to be referable to the same class. They are all conical, all detached, and have surrounding them hills of a volcanic nature, which bear not the slightest analogy to them in appearance. I shall refer to M. Montlosier, and the other writers who have described them, for an account of the Grand and Petit Cliersou and the Sarcouy, and shall confine myself to some remarks on the Puy Chopine, the most extraordinary, certainly, for the assemblage of rocks of which it is made up.

This mountain, which is situated to the N. W. of Clermont, about half way between that city and the village of Pont Gibaud, has long puzzled geologists, from the singular confusion and anomalous structure of the rocks which compose it. Owing, indeed, to the quantity of debris which covers every where its sides, where not concealed by vegetation, it is difficult to determine with precision the position they occupy, or the relations they bear to each other. On climbing to its summit, I found *in situ*, that porphyritic felspar rock, which, from its occurrence at the Puy de Dôme has obtained the name of Domite, unaltered granite, and a conglomerate with a granite base, rocks which seem to be related to each other. Lower down, I observed hornblende rock, which appeared to graduate into the granite; and these four rocks make up, as far as my observations extend, the higher portions of the mountain. On the lower, we have lavas, both compact and vesicular, none of which, so far as I observed, occupy the summit, although M. Montlosier, who examined the spot, doubtless with more attention, says he saw one small portion extending thus high. It should be remembered, that the Puy Chopine, even more distinctly than the Puy de Dôme, is encircled by an amphitheatre of hills, which are comprehended under the names of the Puy Chaumont, and the Montagne des Gouttes. I examined these hills, and found them all to be volcanic, consisting chiefly of a tuff containing portions of scoria, and lavas of various denominations, all cemented together by an ochreous paste. Such, as far as I observed, appears to be the constitution of the Puy Chopine; and the singular combination of rocks which it comprises, whilst it serves to explain its own formation, may, perhaps, furnish us with a clue to the theory of the Puy de Dôme, and the other mountains similarly constituted. Encompassed on all sides by volcanic rocks, and bearing in themselves evidences of the agency of heat, the igneous origin of these latter mountains will scarcely be disputed; but it has been long a question, whether the Puy de Dôme, and the other hills of a like character, have merely been heated in their place, or whether they have been thrown up from below by the agency of a volcano, like some of the hills that have made their appearance in South America, or the Monte Nuova, near Vesuvius.

M. D'Aubuisson seems to incline to the opinion, that the rock of the Puy de Dôme, &c. is only the relic of an extensive stream of lava, which probably covered a large tract on either side of it, but of which all the remaining portions, with the exception of the five hills before alluded to, have since been swept away. Von Buch, on the contrary, whose opinion on such subjects is entitled to great weight, imagines that the mountains composed of domite have been thrown up from below, elaborated from the materials of the fundamental granite, altered partly by the effect of heat, and partly by elastic vapours. The difficulty of supposing so complete a destruction of a stratum as is implied by M. D'Aubuisson's hypothesis, together with the regularly conical form of the Puy de Dôme, and other of the hills alluded to, will prevent our adopting the former opinion, and incline us, in preference, to the theory of Von Buch, which is, moreover, favoured by the circumstance of these hills being, for the most part, situated as it were in a crater, in the midst of rocks which possess every mark of having been the seat of volcanic action.

From what materials this singular rock can have been produced, seems still more problematical; if, as is most probable, from the subjacent granite, what is become of the greater part of the quartz, which forms so essential and abundant an ingredient in the latter rock? why has a heat, capable of dissipating so large a portion of this refractory material, and of reducing the felspar to an harsh and often pulverulent form, left the crystals of augite untouched, and apparently effected no alteration in the mica? These are questions, which, in the present state of our knowledge, it would be difficult to answer, although, it should be remarked, that, in estimating the amount of the quartz dissipated, we should do wrong to calculate it from the difference between the quantity of that mineral existing in the granite and in the domite; but must deduce it from a comparison of the quantity of silex that would be contained in the quartz we suppose to have disappeared, and that existing in the felspar substituted. Now, as felspar contains from 55 to 70 *per cent.* of silex, and quartz frequently not more than 92 *per cent.* the real difference between the constitution of the two rocks is considerably less than might be at first supposed. With regard to the crystals of augite, these, probably, are rather the results of the igneous action, than the unaltered relics of the original stratum. On the other hand, it is impossible to return from viewing the Puy Chopine without feeling a persuasion, that the granite and domites there seen associated, are, in a certain degree, connected with each other, and that, in all probability, the latter has been formed by the agency of heat, modified by peculiar circumstances, out of the materials of the former. Adopting this theory, therefore, as the most probable that has been offered, we may account for the intermixture of the hornblende rock, by supposing that it formed beds in the granite which was thrown up, whilst the unequal operation of heat may explain the occurrence of the latter rock as well as the former, unaltered in the midst of domite.

With regard to the volcanic traps or lavas which occupy the lower portions of the mountain, we may consider them connected with the rocks of the same description, which occur in the Montagne des Gouttes, and Puy Chaumont, contiguous, and that it was in these that the volcanic action to which we ascribe the elevation of the Puy Chopine principally resided. Thus, the expansive power existing in the lavas beneath, may have been the means of elevating the incumbent granite to the height at which we now find it on the summit of the Puy Chopine, producing that occasional alteration in its appearance, which has converted it into the rock we call Domite, and, in the instance alluded to by M. Montlosier, caused it to protrude them both.

The geologist who adopts this view of the subject, will regard the modifications of appearance, observable in the rocks which have been referred to the general head of Domite, as arising from some difference, either in the intensity of the heat to which they were severally subjected, or to the mode of its application. Thus, as M. Montlosier has observed, the Puy de Monchar, a mountain to the N. W. of the Puy de Dôme, on the road to Aurillac, seems merely to have been forced up, without having experienced any material alteration in structure, for though partly composed of scoria, and other volcanic products, yet it is also made up of masses of unaltered granite, unaccompanied, as at the Puy Chopine, with domite, but in such disorder, as plainly demonstrates that they do not exist in their natural position. The second stage of alteration, is seen in the case of the Puy Chopine, where the granite is not only raised by some expansive force, from the spot it originally occupied, but also partially converted into the state of domite, whilst a portion still remains unchanged, to shew from what materials the former was produced.

Lastly, in the case of the two Cliersous, the Grand Sarcouy, and the Puy de Dôme, the change from granite into domite is complete throughout, and the whole is reduced into a spongy and pulverable mass, as is particularly seen in the Puy Sarcouy.

But it is time to take leave of speculations with which, however scrupulously we resolve to adhere to simple deductions from facts, much hypothesis is necessarily blended, and proceed to another description of rocks found in the same neighbourhood, previous to the account we mean to offer of the strata of Mount Dor, and of Cantal, with which the present paper will be concluded.

On the Ancient Volcanic Rocks near Clermont.

We are not to suppose, because the neighbourhood of Clermont is the principal seat of the more recent volcanoes, that no other rocks, referable to the same class, are therefore found about it. The Basalt of Montaudoux, which Dr Boué has remarked to be identical with the rock of Calder, between Glasgow and Edinburgh, evidently belongs to an era much more remote than that of the scoriaceous lava of Graveneire, to which it is so near. The mountain Gergovia, which we have already noticed as consisting, for the most part, of alternations of beds of the fresh-water formation, is capped, however, with a basalt, partly compact, and partly amygdaloidal, containing minute crystals of mesotype, pretty abundantly disseminated, which, of course, must be attributed to a period of time, anterior to the excavation of the valley which it overlooks.—At the Puy Marmont, near the Veyre, about three leagues south of Clermont, on the road to Brionde, I observed an alternation of that species of trap termed by the French Variolite, with limestone beds of the same description with the above.

As this is a fact of some importance, and has not been noticed by former travellers, I may be excused for dwelling a little upon it, in hopes of directing to the circumstance, the attention of geologists, who may correct my statement, in case of my having inadvertently fallen into any error in my description.

The Puy Marmont, then, is capped with basalt, underneath which, is a calcareous rock, identical, both in its external characters and imbedded petrifactions, with that of Gergovia. This is followed by a thick stratum, composed of a sort of tuff, containing imbedded portions, not only of basalt and other trap-rocks, but even of limestone, and with occasional veins of the same substance. In the midst of this tuffaceous rock, rises a ridge, as it were, of basalt, which stretches, vertically, towards the summit of the hill, but does not penetrate the limestone above.

There appeared to be a transition from the tuffaceous rock into the basalt, although I would not be understood to speak confidently on that point; and must therefore leave it for others to determine, whether the imbedded mass is to be considered in the relation of a vein, or merely as composed of a modification of the tuff in which it is found.

I should observe, however, while on this point, that I saw at Brives, a little village within a league of the town of Puy en Velay, columnar basalt, so enclosed in the midst of beds of slaggy lava, and other decided volcanic products, collected into a sort of tuff, that we are compelled to admit the origin of both to be, in this instance, the same. Thus, too, at St Pierre Eyriac, near the same place, the basalt and tuff alternate with each other; and to prove their identity of origin still further, both rocks equally have their fine drusy cavities filled with olivine and hornblende, which have somewhere been called, by the French geologists, Peridote rock. But to return:—Underneath this bed of trap-tuff, if such it be, is the limestone, similar to what occurs generally over the plain of Limagné, so that we have here two alternations of trap, with the most recent limestone beds,—a fact analogous to what has been observed by Spallanzani in Sicily, and, if I recollect right, among the Euganean Hills.

These instances are sufficient to prove, that Trap-rocks, (for it would be assuming too much at present, to style them by any other name,) are found near Clermont, which cannot, by possibility, be referred to the modern order of volcanoes. We may now proceed to mention one or two, the era of which appears more dubious.

A mile or two south of Clermont, near the road to Brionde, we observe, close together, two eminences, one of them constituting a little knoll, hardly perceptible until we are close to it; the other attaining a considerable height, and remarkable for the abruptness with which it rises out of the midst of so level a plain. The first of these is called the Puy de la Peye, or Puy de la Poix; the other, or larger one, the Puy Cronelle. The Puy de la Peye, consists entirely of a species of trap, strongly impregnated with bitumen, which covers the external surface with a glossy varnish, and fills all the crevices in the rock. The trap itself is of that kind which is called, by the French geologists, Variolite, meaning to designate, by that term, a trap-rock, which, from the unequal manner in which it decomposes, exhibits a number of light spots disseminated through a darker ground.

The volcanic nature of the variolite is established by the occurrence in it of occasional fragments of vesicular lava, for, like so many of the rocks of this description in Auvergne, it frequently puts on a tuffaceous character.

The Puy Cronelle, which is about half a mile distant, is composed of the same rock with that we have been describing, equally penetrated with asphaltum. Its conical form leads us to conclude *à priori* that it is of trap, and we find our suspicions verified, when we come to examine it. The lower portions of the hill, which consist of fresh-water limestone, the same which extends over other parts of the plain, are covered with vineyards, which terminate pretty generally where the trap commences.

I was therefore able, by following this indication, to trace pretty exactly the line of junction between the two formations round the greater part of the hill. The line was, indeed, as might be expected, somewhat irregular, and in many instances I observed the limestone sending forth processes vertically into the trap-rock above it. But a still more curious thing was the occurrence of perfectly isolated fragments of the same limestone in the midst of the trap which covers it, apparently unaltered in appearance by the heat to which, as it would seem, it must have been subjected.

Nor is this fact altogether uncommon. I observed in many of the "Coulies" near Clermont, as at Graveneire, fragments of a rock much resembling granite, completely surrounded by the lava; and M. Lacoste of Clermont, the author of some Letters on Auvergne, shewed me, in his collection, two interesting specimens, in one of which a ball of granite was inclosed in a nucleus of basalt, while, in the other, the inclosed mass of granite had a regular octahedral form.

That the Puy Cronelle is volcanic, can hardly be doubted, when we consider the identity of its character with that of the Puy de la Peye contiguous, which, as we said, contains fragments of scoria imbedded. A more difficult point to decide is, whether this and the adjacent rock are relics of a stratum, the remaining portions of which are removed, or whether they have been raised by some force from beneath, through the limestone beds on which they seem to repose.

The latter opinion appears to be most probable, since we can hardly suppose so complete a destruction of a whole stratum, as is implied by the former hypothesis; but it must be confessed, that we have scarcely data to decide whether the production of these rocks is to be referred to an era subsequent to the Mosaic Deluge, or was anterior to that event.

In bestowing on the trap-rocks near Clermont that existed prior to the excavation of our present valleys, the general appellation of *Volcanic*, I own that I have been guided by analogy rather than by actual appearances; there is nothing at least in the external characters of the basalt of Montaudaux or Gergovia which stamps it as the result of the agency of heat, more than that of Arthur's Seat or the Giant's Causeway; yet, if it should afterwards appear that the basalts of Mont D'Or have clearly resulted from fire, I do not know how we can refuse our assent to the probable inference, that those near Clermont have a similar origin, as they seem almost continuous with the former. The reader will therefore be pleased to suspend his judgment on this point, until he shall have perused that part of the paper which relates to the rocks in Mount D'Or and Cantal.

Magdalen College, Oxford,
July 30. 1820.

Art. XII.—*On a New Method of Working Lunars.* By Mr William Marrat, Member of the Philosophical and Literary Society of New York, and Lecturer on Natural Philosophy and Astronomy, Liverpool. In a Letter to Dr Brewster.

THE new method of working lunars which I now send you, is superior, taking it altogether, to any that I have yet seen. It is as short as any, and the navigator sees clearly what he is doing; whereas, by most of the other methods, he is always in the dark, knows nothing of what he is about, and, for any thing that he can tell, his result may be either right or wrong. The peculiar excellence of this method consists in this: It proceeds regularly on first principles, and is extremely easy to commit to memory: It is as easily understood as any other method, and, when once known, the whole theory of the lunars is clearly understood. The logarithms to five places, and which are contained in the common books of navigation, are quite sufficient, and the result of each proportion needs only be taken out to the nearest minute. The whole of the work, from beginning to end, can be performed in ten minutes. The only additional table required, beside the common logarithmic tables, is one for *second differences*, (the 29 in the Requisite Tables), entitled, " A Table for computing the final effect of Parallax on the distance between the Sun and Moon, or the Moon and a Fixed Star;" and even this is only necessary when extreme accuracy is required.

Let MZS (Plate III. Fig. 2.) be a spherical triangle, in which MZ is the moon's zenith distance, ZS the zenith distance of the sun, or star, and MS the observed distance. Let also *m s* represent the true distance, and let fall the perpendiculars *m n*, S *o*, and draw the perpendicular ZN. By the principles of Spherics,—As the tangent of half the base is to the tangent of half the sum of the sides, so is the tangent of half the difference of the sides to the tangent of half the difference of the segments of the base; which half difference being added to half the base, gives the greater segment, but being subtracted from half the base, gives the lesser segment. Hence we have the segments MN, and NS

Again, tan MZ : tan MN : : rad. : cos ZMN, and considering M *m n* as a plane triangle, by the principles of plane trigonometry we have M *m* : M *n* : : rad. : cos ZMN; therefore, by equality, tan MZ : tan MN : : M *m* : M *n*. In the same manner, we have tan SZ : tan SN : : S *s* : *s o*. Now, M *n*, and *s o*, are the corrections; and it is evident from the figure, that when the angle M is acute, M *n* must be subtracted from the apparent distance, but added when that angle is obtuse; also when the angle S, at the sun or star is acute, *s o* must be added, but subtracted when it is obtuse. After the observation is made, a figure may be drawn by the hand, sufficiently exact for ascertaining the nature of the angles at M and S; and this is the only ambiguity which it is necessary to attend to in solving the problem by this method.

Example.—On the 7th of June, sea account, at 6h 37′ P. M. in Longitude 120° W. by account, the observed distance of the moon's farthest limb from Aldebaran, was 39° 7′ 4″, the observed altitude of the star 43° 18′, and the observed altitude of the moon's lower limb 52° 52′;—Required the true distance?

The apparent altitude of the star is found to be 43° 14′, that of the moon 53° 04′, and the apparent distance of the moon and star 38° 52′, also the moon's horizontal parallax 54′ 35″. Now, in the triangle MZS, we have MZ, the moon's co-altitude = 36° 56, ZS = 46° 46′, and MS = 38° 52′, to find the necessary corrections. It is well known that M *m* is equal to the difference between the moon's parallax in altitude and the refraction, and that S *s* is the difference between the sun's parallax and refraction, where the sun and moon are observed; but S *s* is equal only to the refraction, when a star and the moon are observed, or 1925″.

In this example, M *m* is found to be 32′ 05″, or 1925″, and S *s* = 1′, or 60″.

ZS = 46° 46′	2)38° 52′ = MS	tan ½ MS,	19° 26′ ... 9.54754
ZM = 36 56	19 26 = ½ MS	tan ½ Sum,	41 51 ... 9.95215
2)83 42		tan ½ Diff.	4 55 ... 8.93462
½ Sum, 41 51			18.88677
2) 9 50		tan ½ Diff. seg.	12° 19′ ... 9.33923
½ Diff. 4 55			19 26
		Sum,	31 45 = NS
		Diff.	7 07 = MN

Tan MS =	36° 56′ ...	9.87606	Tan ZS =	46° 46′ ...	10.02680
Tan MN =	7 07 ...	9.09640	Tan NS =	31 45 ...	9.79156
Log M *m* =	1925″ ...	3.28443	Log S *s* =	60″ ...	1.77815
		12.38083			11.56971
Log M *n* = 60)32.0″	5′.20″	2.50477	Log *s o* =	35″	1.54291

Apparent distance, -	38° 52′ 00″
M *n*, - -	— 5 20
s o, - -	+ 00 35
Correction for 2d difference,	+ 00 11
True Distance required,	38 47 26

Liverpool, *Nov.* 4. 1820.

Art. XIII.—*On the Respiration of Plants.* By W. H. Gilby, M. D., M. G. S. In a Letter to Professor Jameson.

Having been much interested in that inquiry which my friend Mr Ellis has so ably and ingeniously conducted in his Treatise upon the chemical changes produced in the Atmosphere by the Respiration of Plants, and having myself executed many experiments upon the subject at the time of my graduation, I thought a short account of the nature of those experiments, and of the conclusions to which they gave rise, might not be unworthy your notice. I am the more anxious to give such a statement, because it frequently happens, that the pages of our journals are still filled with many frivolous observations, sometimes gravely announcing as a new discovery, that plants do really vitiate the air, and at other times repeating the old notions of Priestley, all tending to shew a complete oversight of Mr Ellis's truly philosophical work. In a work even written in a very acute and sensible manner by the Reverend Mr Keith, upon the Physiology of Vegetables, the reader is left very much in the dark with regard to the ultimate question of the real respiratory function of plants. He embodies, as far as I recollect, the opinions of the most sensible writers upon the matter, which are oftentimes in contradiction, but neglect to satisfy us, by drawing any reconciling conclusion. Several writers, in particular Sennebier, Ingenhousz, and Saussure, have shewn that the changes produced on the air are quite different, according as the plant is placed in the sunshine or in the shade. In the shade, the air is vitiated by the disappearance of the oxygen, and the formation of carbonic acid; on the contrary, under insolation, the carbonic acid, if any be present, is rapidly decomposed, and the air is again improved by the restitution of the oxygen.

The rapidity with which this process takes place is truly astonishing, as the following experiment, among many I have made with this view, will demonstrate. I filled a glass jar, holding 21 cubic inches, with a mixture of common air and carbonic acid, in the proportion of 70 parts of the former to 30 of the latter. I then introduced into the jar a bundle of fresh grass, which displaced, by previous measurement, exactly 2 cubic inches of air, and submitted the whole to the full light of the sun during four hours, the inverted jar being surrounded by mercury in a saucer. At the close of this time, I found, that only 2 parts out of the 100 were subtracted by lime-water, while not less than 41 parts were consumed by phosphorus. In estimating, therefore, the proportion of carbonic acid and oxygen before and after the experiment, it appears, that 26.3 of oxygen were added in this short space of time, over and above the 14.7 originally existing; or if we compute the quantity of each gas before and after the experiment, this will be the proportion:

		Cubic In.			Cubic In.
At the beginning of the Experiment there were in the Jar,	Of Nitrogen,	10.507	At the close of the Experiment there were	Of Nitrogen,	10.507
	Of Carbonic Acid,	5.7		Of Carbonic Acid,	37
	Of Oxygen,	2.793		Of Oxygen,	7.79
		19.000			18.677

Very few, I imagine, would hesitate in admitting, that this conversion of carbonic acid into oxygen, is entirely the result of the chemical action of the sun's rays. I thought, however, it would be interesting to establish this point by experiment.

Mr Ellis had suggested to me the idea of confining plants in an artificial atmosphere of carbonic acid and common air, under jars of different coloured glass, and thus of insulating them. Finding it impossible, however, to procure jars of the required colours, I adopted the following expedient in performing the experiment. I procured three phials, holding exactly 3½ cubic inches, into each of which I thrust a bundle of grass, occupying

$\frac{3}{10}$th of a cubic inch. I then filled them with atmospheric air, mixed with a certain proportion of carbonic acid. Having stoppered them accurately, I dipped one of them in a glass jar filled with a transparent infusion of litmus; a second in a similar vessel of a clear infusion of roses; and the third was placed in a jar of pure water. I then, by quickly turning them, contrived that each jar should stand inverted upon a plate; and thus prepared, I insolated them during four or five hours; and if there was not more than 20 or 25 *per cent.* of carbonic acid, I always found, that the same change had taken place in each phial, namely, that the whole of the carbonic acid, excepting 2 or 3 parts, had been converted into oxygen. But if the proportion of carbonic acid was greater, suppose 40 or 50 *per cent.* I invariably found, that there was more oxygen in the litmus and pure water phials, than in that immersed in the red tincture. I instance the following indifferently, out of very many experiments that I have performed, upon this point.

I exposed the three jars, with their respective phials, to a full sunshine on the 5th of July. At the beginning of the experiment, there were in each phial, of Carbonic Acid, 43.00; Oxygen 11.97; Nitrogen 45.03 = 100. At the expiration of four hours, the analysis gave me *,—

In the Phial belonging to the Red Infusion.		In that in the Litmus Infusion.		In that in the Clear Water.	
Carbonic Acid,	19.5	Carbonic Acid,	12.5	Carbonic Acid,	12
Oxygen, -	29.5	Oxygen, -	36.5	Oxygen, -	37
Nitrogen, -	51.0	Nitrogen, -	51.0	Nitrogen, -	51
	100.0		100.0		100

It thus appears, that the red rays are sufficiently powerful to decompose the carbonic acid, if the proportion of it be small; but if a larger proportion of it be present, then it is evident that more oxygen is elaborated by the violet rays than by those of the red colour.

* In repeating the experiment, but varied, by substituting cabbage leaves, I found that very little change had taken place in the mixed air, which seems to prove, that their leaves, on account of the delicacy of their coats, are much more permeable by air.

It is here fit that I should advert to a circumstance which is evident from the tabular statement I have given. It will be seen, both in that and in the one before it, that the proportion of nitrogen to the other constituents, was greater at the close than at the commencement of the experiment. This, however, is a complete illusion. There is in fact no increase of nitrogen. I am quite clear, that the apparent addition of it arises from some portion of carbonic acid, which the sun has not had time or power to decompose, being retained in the leaves, and in this way lessening the absolute quantity of air in the phial; so that the more carbonic acid is retained in the leaves, the greater will be the ratio of nitrogen. To make this perfectly clear:—In the experiment above related, if all the carbonic acid, with the exception of 19.5 (the quantity remaining in the red phial) had been decomposed, we ought certainly to have found 35.47 of oxygen; but it appears that only 29.5 were indicated by the eudiometer, and therefore, we cannot hesitate in admitting, that 6 *per cent.* were retained in the leaves. The result of one or two trials would not make me so confident as to this conclusion; but having invariably found, from a very frequent repetition of my experiments, that the carbonic acid that disappears is not accounted for in the oxygen formed, I think the inference which I have drawn is perfectly fair, and indeed unavoidable. This apparent accession of nitrogen is noticed by Saussure, in his admirable work entitled Recherches, &c. as a real production of that gas; but I conceive that the circumstance is much more naturally accounted for by the explanation I have just given. If this explanation be correct, it will serve to shew, that this decomposition of carbonic acid takes place within the substance of the leaf, and not exterior to it, as Mr Ellis imagines.

I shall now proceed with the chief object of this paper, to inquire how far the respiration of plants is conducive to the purification of the atmosphere. As far as is known, from the experiments and observations of the ablest inquirers, it appears, that plants in darkness, in the shade, and perhaps in the common light of the day, generate carbonic acid, and that only during sunshine is there any evolution of oxygen. The question, therefore, is, Has this partial production of oxygen any effect in diminishing, not only the vitiation of the atmosphere consequent on animal respiration, but is it even operative in counterbalancing the exhalation of carbonic acid during the natural respiration of the plant? The extraordinary rapidity with which plants decompose carbonic acid in the light of the sun, can, I apprehend, have very little avail, as a proof of their correcting influence on the atmosphere. The circumstances under which the plant is placed, by the conditions of the experiment, have no resemblance to its natural respiration. In the experiments of Ingenhousz, Sennebier, Saussure, &c. which have been considered as corroborative of the beneficial influence of plants on the atmosphere, there was always present a very considerable portion of carbonic acid; while, in ordinary circumstances, they are surrounded by an atmosphere which contains, according to Thenard, not more than $\frac{1}{1738}$th part of that gas. There can be no doubt, if the atmosphere contained a considerable portion of carbonic acid, that the oxygenating power of plants, when exposed to the sun, would have a very material influence in preventing an undue quantity of carbonic acid. For this effect, however, to take place, the difficulty is forced upon us, of supposing that the plant is endowed with the faculty of selecting and inhaling the small quantity of carbonic acid, to the exclusion of the atmospheric air. Besides the improbability of such an idea, it is likewise contradicted by the experiments of Ingenhousz, who found, that plants had the power of imbibing indifferently any air with which they happened to be in contact, whether oxygen, hydrogen, or nitrogen. Independent, too, of these objections, it supposes the discontinuance of what may with propriety be considered as the natural process of respiration. In Mr Ellis's work, the distinction is very clearly maintained, between the artificial change during sunshine, and the necessary function of the plant. In the one case, the oxygen of the atmosphere is consumed, and is replaced by an equal quantity of carbonic acid, being in fact precisely the process which takes place in the respiration of animals; and this he calls the proper and natural function of the plant. The reverse of this change, under exposure to light, he considers as the mere effect of the chemical action of the sun's rays, and is by no means to be considered as a property necessary to the life of the plant. In proof of this opinion, I refer to the arguments in his treatise, which I think are as conclusive as possible. If this statement be correct, it shews clearly the absurdity of supposing, that the amelioration of the atmosphere can be maintained, on the opinion above stated, as it imagines the discontinuance of a part of the natural economy of vegetation. In rejecting this opinion, we must conclude, that the formation of carbonic acid continues even during sunshine. If so, it becomes a matter of interest, with regard to the question in view, whether the carbonic acid is formed without or within the leaf. In the former case, the conclusion is unavoidable, that the air is always vitiated by vegetable respiration; for if the carbon is exhaled from the leaf, and exterior to it unites with the oxygen of the air, as soon as the carbonic acid is formed, it immediately mixes with the atmosphere, and is altogether withdrawn, both from the influence of the sun and plant. If, on the other hand, the carbonic acid have its origin in the leaf, it will, indeed, during sunshine, be decomposed; but only so much oxygen will be given out, as was necessary for its preparation, and of course the air will receive no improvement from this cause; so that in whatever way we view the *respiration* of plants, we shall find, that it is impossible to ascribe to them any beneficial effect in maintaining the uniform purity of the atmosphere.

It is the opinion of some, that the vegetable kingdom has the power of decomposing the water which they imbibe. It may be so. But we have no proof of it by experiment, that I am aware of. On the contrary, it appears, in all the experiments of Sennebier, Saussure, and in numerous trials of mine, that no more oxygen was given out, than what could most correctly be accounted for from the carbonic acid employed. And even when plants have been allowed to vegetate for a number of days and nights in a confined portion of atmospheric air, as in an experiment of Ingenhousz, and as also (if I remember right) in one mentioned in Sir H. Davy's Agricultural Chemistry, its constitution at the close had suffered no change, the carbonic acid which had been elaborated during the night, being, during sunshine, again resolved into its original elements.

Some, again, have supposed, that the decomposition of the carbonic acid which is contained in the water imbibed in the plant, is another source by which oxygen is supplied to the atmosphere. But, as far as I know, the supposition is unsubstantiated by any satisfactory fact or experiment.

W. H. Gilby.

Art. XIV.—*Account of the Earthquake which occurred in India in June* 1819. By Captain Macmurdo.

In a former number of this Journal, we gave a short account of the remarkable earthquake which took place in India in June 1819, and have now the pleasure of communicating to our readers the description of it, as given by Captain Macmurdo in a memoir read before the Bombay Literary Society *.

Captain Macmurdo states, that on the 16th June 1819, between fifteen and sixteen minutes before 7 o'clock p. m., a violent shock took place in Cutch, which lasted about two minutes, and which, when at its height, occasioned a motion of the earth so undulatory, that to keep the feet was no easy matter, while the waving of the surface was perfectly visible. Before 11 o'clock p. m. three more shocks, but of a trifling nature, were experienced. On the next day, the 17th, the earth was frequently in motion, attended by gusts of wind, and a noise like that of wheeled carriages. For some time before 10 a. m., these symptoms intermitted only for a few minutes until about a quarter to 10, when a severe shock was experienced; this lasted for about fifty seconds, and brought down a number of shattered buildings. Until the beginning of August, no day passed without one or more shocks, but subsequently they became less frequent, only occurring every third or fourth day. During the whole of this time the shocks were generally very slight, and many persons did not feel what was sensibly felt by others. Subsequent to this period shocks became still less frequent, occurring at uncertain periods of many days' interval, until the 23d of November, which seems to be the last distinct one we have had.

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* For this extract, we are indebted to an interesting periodical work, the "Asiatic Journal."

The shock of the 16th was the only one by which the face of nature or the works of men were materially injured or changed. In the province of Cutch it may be fairly asserted that no town escaped feeling its effects, either in the fall of houses or in that of its fortifications. The capital, Bhooj, suffered in many respects more severely than any other town; nearly seven thousand houses, great and small, were overturned, and eleven hundred and forty or fifty people buried in the ruins; and of the original number of houses which escaped ruin, about one-third are much shattered. There are, or rather were, a great number of fortified towns throughout Cutch, the works of which are in general destroyed. Thera, which was esteemed the best in the province, has not a stone unturned; the town fortunately did not suffer in the same unparalleled degree, although few or no houses were left securely habitable. The total of lives lost, according to the best information I have been able to procure, does not exceed two thousand.

As far as comes under our notice, the face of nature has not been much altered by the shocks. The hills, (which are most likely to shew its effects), although from their abruptness, and conical or sharp ridgy summits, and from the multitude of half-detached rocks with which they are covered, they might have been expected to have displayed strong marks of the convulsion by which they were agitated, have in no instance, to my personal knowledge, suffered more than having had large masses of rock and soil detached from their precipices. I have seen none with cones flattened, or in any remarkable degree altered. At the moment of the shock, vast clouds of dust were seen to ascend from the summit of almost every hill and range of hills. Many gentlemen perceived smoke to ascend, and in some instances fire was plainly seen bursting forth for a moment. A respectable native chieftain assured me, that from a hill close to the one on which his fortress is situated fire was seen to issue in considerable quantities; and that a ball of large size was vomited as it were into the air, and fell to the ground still blazing on the plain below, where it divided into four or five pieces, and the fire suddenly disappeared *. On examining the hill next

* Fire-balls are mentioned as having been seen to rise from the earth during earthquakes in other countries; and some speculators have collected together facts

day, (the chieftain stated), it was found rent and shattered, as if something within had sunk; and the spot where the fire-ball was supposed to have fallen, bore marks of fire in the scorched vegetation.

The rivers in Cutch are generally dry, (except in the monsoon), or have very little water in them. Native accounts seem to confirm the fact of almost the whole of their beds having been filled to their banks for a period of a few minutes, and according to some for half an hour. They are said to have subsided gradually. This convulsion of nature has affected the eastern and almost deserted channel of the river Indus, which bounds Cutch to the westward, and the Runn or desert, and the swamp called the Bhunnee, which isolates the province on the north, in a more remarkable manner than it has any other part of the country. I myself have seen this branch of the Indus forded at Luckput, containing water for a few hundred yards about a foot deep; this was when the tide was at ebb, and when at flood the depth of the channel was never more than six feet, and about eighty or one hundred yards in breadth; the rest of the channel at flood was not covered in any place with more than one or two feet of water. This branch of the river Indus, or, as it may with more propriety be termed, inlet of the sea *, has since the earthquake deepened at the fort of Luckput to more than eighteen feet at low water, and on sounding the channel it has been found to contain from four to ten feet from the Cutch to the Sindh shore, a distance of three or four miles. The Ali-bund has been damaged, a circumstance that has re-admitted of a navigation which had been closed for centuries. The goods of Sindh are embarked in craft near Ruhima Bazar and Kanjee Kacote, and which, sailing across the Bhunnee and Runn, land their cargoes at a town called Kurra, on the north of Cutch. The Runn, which extends from Luckput round the north of this province to its eastern boundary, is not at present fordable

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of this description, with the view of proving that meteoric stones are not truly meteoric, but are of tellurian formation, having been projected from the interior of the earth. This improbable hypothesis is advanced in a work lately published in Germany.—Ed.

* It is many years since the eastern branch of the Indus has been almost deserted by the waters of the river.

except at one spot, although it has heretofore at this period of the year been dry; and should the water continue throughout the year, we may perhaps see an inland navigation along the northern shore of Cutch, which, from stone anchors, &c. still to be seen, and the tradition of the country, I believe to have existed at some former period. Sindree, a small mud-fort and village belonging to the Cutch government, situated nearly where the Runn joins the Indus, was overflowed at the time of the shock. The people escaped with difficulty, and the tops of the houses and wall are now alone to be seen above the water. The fate of Sindree was owing to its situation, for there cannot be a doubt of all the Runn land having, during the shock, sent forth vast quantities of water and mud; and the natives described a number of small cones of sand six or eight feet in height, the summits of which continued to bubble for many days after the 16th *.

ART. XV.—*A Method of constructing Bee-Hives of Wood, so as to resist the Cold of the severest Winter.* By the Reverend ANDREW JAMESON. In a Letter to Professor JAMESON.

SO many are the inconveniences connected with using bee-hives of straw, that apiarians have had recourse to wood in constructing them, and with considerable advantage. Straw-hives must be thatched during winter to protect the swarm from the cold;—they must be thatched and screens must be put up before them during the hot summer months, to protect the wax and honey from the fatal effects of the heat: and this thatching, so useful at both seasons, is at all times an evil, as it serves to harbour many insects hurtful to the hive, becomes a lurking place for mice, and in general retains a quantity of moisture, very prejudicial to the health of the bees. Another serious evil

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* In many countries, remains of marine animals, sometimes of great magnitude, are found in alluvial strata, considerably above the present level of the sea, while in others, terrestrial productions appear under the surface of the waters of the ocean. In some cases, these phenomena are to be explained by a reference to the agency of earthquakes, and the action of volcanoes, as stated in the text.—ED.

connected with straw-hives, is the impossibility of securing them from *human* depredators. M. Huish has proposed one of the most useful methods of securing the straw-hives from thieves, but still there is no great difficulty of very quietly robbing his secured hive.

To remedy these evils, wooden-hives have been proposed, and could they be so constructed as to resist the cold during winter, and heat of summer, without thatching, a very important end would be gained. To attain this object, wooden-hives have been made of deal plank very thick, even as thick as two inches; still, should the winter be very *hard*, thatching must be resorted to,—one of the evils connected with the old straw-hive. By the application of a good non-conductor of heat, secured from the action of the weather, this evil may be completely cured. Let us suppose a hive made of wood, of whatever shape, is 12 inches diameter; then, let another hive of the same material be made 2 or 2½ inches larger; place the one within the other, and fill up the space left by the difference of size with powdered charcoal, hard rammed down; nail a fillet of wood at the bottom, to connect the two hives and to prevent any of the charcoal falling out, or damp ascending through the coating, which would destroy in some measure its non-conducting power. The bee-door edges must be secured in the same manner. By this plan, you have (out of sight) a non-conductor more powerful than straw, at all times possessing its non-conducting property, which the straw only has when *dry;* and no harbour made for vermin of any kind. It is proper here to state, that great care must be taken to have the charcoal put into its place in as dry a state as possible. Should charcoal not be to be had, any other non-conductor of heat may be used, as dry saw-dust, chopped straw, feathers, &c., but the charcoal is to be preferred, not only as better suited from its most powerfully resisting the transmission of heat, but as less liable to absorb moisture, and so destroying that power.

As the coating prevents the transmission of the internal heat of the insects in summer, this will tend to raise the temperature too high for the health of the bees. This inconvenience may be obviated by a small perforation made through the entire hive at one of the corners, immediately under the projecting part of the roof. To prevent any of the charcoal being moved, a tube must be inserted as long as the thickness of the entire hive, a plug made to fit it of the same length; and when the ventilation is used, care must be taken that no light be perceptible by the insects, which may be effected either by partially withdrawing the plug, or hanging over the hole, at a *little distance* from the outside of the hive, a piece of black cloth. Perhaps two such ventilating holes may be required; but experience must determine this.

The double hives I now recommend, may be used by those who think them *too heavy*, merely as *cases for the hives* which may be in use; removing the covers or cases when any operation is to be performed on the hive.

Since writing the above, I have seen a contrivance for securing bee-hives from being stolen superior to that recommended by M. Huish, but only applicable to *wooden hives* *. The hive is so attached to a stone pedestal, as to render it necessary either to knock the hive in pieces, or carry off *nearly* 200 *lb. weight* before the thief can secure his prey. By this simple contrivance, all the hives in the extensive apiary at Applegarth-Manse, belonging to the Reverend William Dunbar, are secured.

MANSE OF ST MUNGO,
June 4. 1820.

ART. XVI.—*Observations on the Currents and Animalcules of the Greenland Sea.* By WILLIAM SCORESBY, jun. F. R. S. E. M. W. S., &c. In a Letter to Professor JAMESON.

FEW circumstances among the minuter works of the creation, have struck me with so much surprise, as the appearance of myriads of animalcules, in a sea perpetually covered with ice, exposed to an average temperature fifteen degrees below the freez-

* In constructing wooden hives, care must be used in selecting the wood, if possible free of knots, and well seasoned. Fir, in general, will be found best suited for the purpose; ash should be avoided, both as apt to yield to the weather and warp, and also as being one of the best conductors of heat of the woods generally used in this country.

ing point, and subject to be frozen, on some occasions at least, during every month of the year.

In an extract from the "Account of the Arctic Regions," which appeared in the 2d Volume of the Edinburgh Philosophical Journal, there was a notice of these animalcules, and of a minute species of Medusa. In connection with these facts, I have now to present a few more particulars respecting multitudes of animalcules, observed in the Greenland Sea during the present summer, together with some remarks on an extraordinary superficial current.

On the 29th and 30th of July last, being surrounded with ice-fields, at no great distance from the coast of West Greenland, a little to the northward of the part first discovered by Henry Hudson in 1607, some interesting appearances were observed in the sea. A singular superficial current, extending only to the depth of a few feet, first engaged my attention. By the action of this, all the smaller pieces of ice, of which there was a great quantity near, were carried towards the north, at the rate of more than a mile an hour; but such pieces as had a depth of 8 or 10 feet or upwards, were not sensibly affected by it. Then the fields and floes around, which were very ponderous, seemed to be at rest, and even the ship's course was a little affected by it, as compared with the heavy ice; but as regarded the thinnest pieces, the apparent lee-way of the ship was two or three points. In consequence of this, the ship was repeatedly struck by the ice under the influence of the current, and her progress much retarded by it. This partial current was the more extraordinary, as it occurred during a calm that had prevailed above two days.

In the same situation where this current was observed, we sailed for several leagues in water of a very uncommon appearance. The surface was variegated by large patches, and extensive streaks of a yellowish-green colour; having the appearance of an admixture with flowers of sulphur or mustard. Whenever the ship passed through any of this peculiar water, the patch or streak was divided, and did not again unite; from which circumstance, the colouring matter was found to be quite superficial. Suspecting it to be of an animal nature, a quantity of the yellowish-green water was procured, and, on examination, by the microscope, was found to contain animalcules in immense numbers. The larger proportion of these, consisting of a transparent substance of a lemon-yellow colour, and globular form, appeared to possess very little power of motion; but a part, amounting, perhaps, to a fifth of the whole, were in continual action *. Some of these being seen advancing by a slightly waving motion, at the rate of $\frac{1}{180}$th of an inch in a second, and others spinning round with considerable celerity, gave great interest and liveliness to the examination. But the progressive motion of the most active, however distinct and rapid it might appear under a high magnifying power, was in reality extremely slow, for it did not exceed an inch in three minutes. At this rate, they would require 151 days to travel a nautical mile. The Condur, it is generally believed, could fly round the globe at the equator, assisted by a favourable gale, in about a week; these animalcules, in still water, could not accomplish the same distance in less than 8935 years!

The vastness of their numbers, and their exceeding minuteness, are circumstances, discovered in the examination of these animalcules, of uncommon interest. In a drop of water, examined by a power of 28,224, (magnified superficies), there were fifty in number, on an average, in each square of the micrometer glass of $\frac{1}{840}$th of an inch in diameter; and as the drop occupied a circle on a plate of glass containing 529 of these squares, there must have been in this single drop of water, taken accidentally from the surface of the sea, and in a place by no means the most discoloured, about 26,450 animalcules. Hence, reckoning sixty drops to a dram, there would be a number in a gallon of water, exceeding by one-half the amount of the population of the whole globe. How insignificant, in point of numbers, is man! What a conception does it give us of the minuteness and wonders of creation, when we think of more than 26,000 animals living, obtaining subsistence, and moving at their ease, without annoyance to one another, in a single drop of water!

* This kind resembled the animalcule represented in the "Account of the Arctic Regions," Plate xvi. fig. 18.

The diameter of the largest of the animalcules was only the $\frac{1}{2000}$th of an inch, and many only the $\frac{1}{4000}$th. The army which Buonaparte led into Russia in 1812, estimated at 500,000 men, would have extended, in a double row, or two men a-breast, with 2 feet 3 inches space for each pair of men, a distance of $106\frac{1}{2}$ English miles;—the same number of these animalcules, arranged in a similar way in two rows, but touching one another, would only reach 5 feet $2\frac{1}{2}$ inches! A whale requires a sea, an ocean, to sport in; about a hundred and fifty millions of these animalcules would have abundant room in a tumbler of water.

Art. XVII.—*Remarks on Professor Hansteen's* "Inquiries concerning the Magnetism of the Earth." (Concluded from Vol. III. p. 138.)

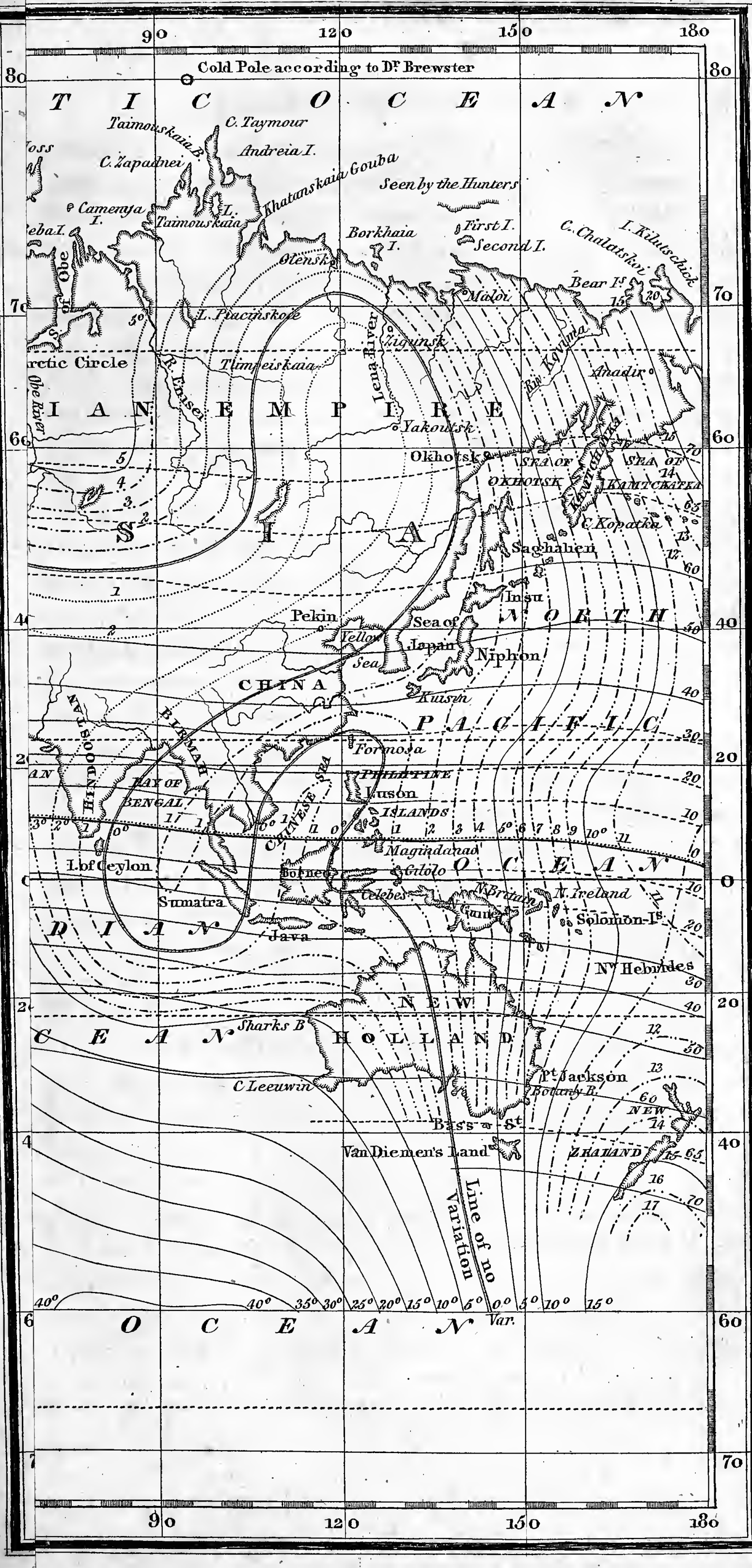
THE few facts hitherto discovered respecting the nature of artificial magnets, afford us little assistance in examining the great terrestrial magnet: the acquaintance we have with the one, is much too limited for illustrating the phenomena of the other; and our knowledge of each is almost wholly derived from observations which have no direct reference to any thing beyond its own properties. So long, however, as this continues to be true, our researches concerning the magnetism of the earth cannot be expected to possess the precision and completeness characteristic of science; and while so many other obstacles continue to retard the progress of both, great part of the subject must remain enveloped in obscurity. At first view, indeed, the results present nothing but the most perplexing intricacy. The magnetic intensity varying at different times, and at different places in the same time; the lines of equal dip, and the lines of equal variation, arranged in such complex forms, and changing their position with inconstant rapidity, at one time to the east, at another to the west, appear to indicate the agency of forces so numerous and so entangled, as to set our power of estimating them for ever at defiance. By degrees, however, some kind of regularity is found to exist among the various observations: the effects of certain leading principles arise dimly above the crowd of minute appearances; and though the whole remains incapable of a satisfactory explanation, and many points are still quite unintelligible, the experiments of three centuries have at least been submitted to arrangement, and put in a state to receive fresh augmentation and correction.

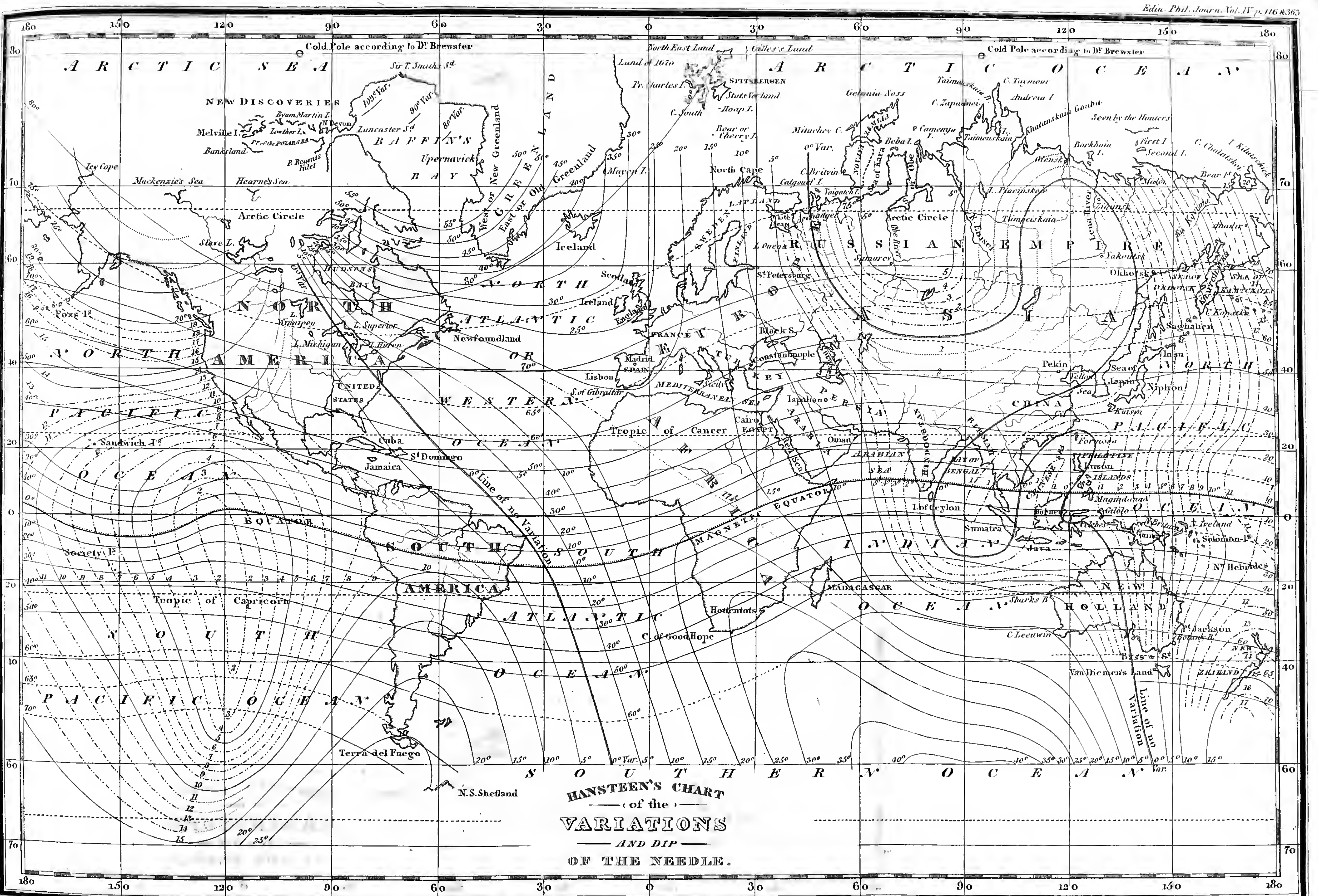
It is obvious, that if our acquaintance with any of the three classes of phenomena above alluded to, with the intensity, the dip, or the variation, were accurate and extensive enough, it would be sufficient, of itself, for enabling us fully to ascertain the magnetic condition of the earth, and to exhibit, *à priori*, the various modifications of the other two. Hence, it is an important restriction of the problem in its actual state, that every attempt directed to account for one particular branch, shall be rejected if it fail to comprehend them all; while, on the other hand, an hypothesis possessing this quality, acquires a proportionable increase of probability. It farther deserves to be remarked, that of those three properties, the variation is the one concerning which we are furnished with the most abundant data: it was first detected, experiments with regard to it are most easily performed, least liable to error, and immediately applicable to navigation. To this property, accordingly, the attention of inquirers has in general been chiefly directed; and Mr Hansteen, without overlooking the intensity and dip, has naturally grounded his main conclusions on the aspect of the variation. Whoever has attempted to collect observations of this sort, or even cast his eye on a magnetic chart, will at once be sensible of the extreme uncertainty attending speculations on the subject, and of the need there is, not only for immense industry to accumulate materials, but also for the most vigilant discrimination to separate the correct from the erroneous, and the ambiguous from the decisive. How far Mr Hansteen has succeeded in this enterprize, will be variously determined: his theory must stand or fall by the conformity of its predictions to events; and in the mean time, it demands the inspection of naturalists, because it is founded on a very large induction of facts, and because the consequences, if true, would be of the very highest importance.

On looking over the chart of variations for 1787, which we have chosen as the most perfect specimen of Mr Hansteen's

Magnetical Atlas *, it will be seen, that his line of no variation, (the dotted line in that figure), commencing to the west of Hudson's Bay, proceeds in a south-east direction, through the lakes of North America, past the Antilles and Cape St Roque, till it reaches the Southern Ocean; that again it appears below New Holland, crosses that island, extends with a double sinuosity through the Indian Archipelago, and, after stretching along the east coast of China, and up to the latitude of 71°, forms a semicircular bend, and passes northward through the mouth of the White Sea. In all those windings, a system of *variation-lines* accompanies it on both sides, with more or less regularity, according to the distance; but the peculiarity which principally engages the author's attention, and of which he is at most pains to demonstrate the reality, is the position of those lines near their several extremities. By a multitude of observations, the evidence of which it is difficult to resist, Mr Hansteen thinks it proved that there are *four points of convergence* among the lines of variation on the globe, a weaker and a stronger in the neighbourhood of each pole. Comparing the observations made at one time with those made at another, it farther appears, that those points have a constant motion, which, admitting the hypothesis of its uniformity, may easily be calculated on the principle that leads to its discovery. At present, it would seem, the stronger point (A) of the southern hemisphere, is situated not far to the S.W. of Van Dieman's Land, at the distance of 21° 8′ from the pole, and of 132° 35′ E. from the meridian of Greenwich; the weaker point (*a*) of the same hemisphere, is situated to the S.W. of Terra del Fuego, at the distance of 11° 44′ from the pole, and of 135° 59′ W. from Greenwich: the stronger point (B) of the northern hemisphere, again, is found above the American continent, distant 20° 22′ from the pole, 89° 24′ W. from Greenwich; and the weaker point (*b*) of the same hemisphere, in the Arctic Ocean, 4° 48′ from the pole, 140° 6′ E. from Greenwich. Each stronger point thus lies opposite, though very seldom diametrically opposite to the other; the weaker points in like manner. The motion of both northern points is from west to east obliquely; of both southern

* This Chart, forming Plate IV will be given in next Number.


Cold Pole according to Dr. Brewster
TIC OCEAN
C. Taymour
Taimouskaia B.
Andreia I.
C. Zapadnei
Khatanskaia Gouba
Seen by the Hunters
Camenja I.
Taimouskaia
L.
Borkhaia I.
First I.
Second I.
C. Chalatskoi
I. Kilutschick
Olensk
Obe
Bear Is.
Malou
L. Piacinskoie
Lena River
Ziguinsk
Riv. Kovima
Arctic Circle
R. Enisei
Timpeiskaia
Anadir
Obe River
IAN EMPIRE
Yakoutsk
Okhotsk
SEA OF OKHOTSK
SEA OF KAMTCHATKA
KAMTCHATKA
C. Kopatka
SIA
Saghalien
Insu
NORTH
Pekin
Sea of Japan
Yellow Sea
Niphon
CHINA
Kusin
PACIFIC
HINDOOSTAN
BIRMAH
Formosa
PHILIPPINE ISLANDS
Luson
BAY OF BENGAL
CHINESE SEA
Magindanao
OCEAN
I. of Ceylon
Borneo
Gilolo
Celebes
N. Britain
N. Ireland
Sumatra
Guinea
Solomon-Is.
DIAN
Java
Nw. Hebrides
NEW HOLLAND
Sharks B
CEAN
C Leeuwin
Pt. Jackson
Botany B.
NEW ZEALAND
Bass St.
Van Diemen's Land
Line of no Variation
OCEAN
Var.
90
120
150
180
80
70
60
40
20
0



Drawn & Engd by W.H. Lizars
Edinburgh Published by A. Constable & Co. 1821.

points from east to west, also obliquely: and, according to a great, though avowedly not a sufficient number of observations, Mr Hansteen calculates, that the point B will accomplish its circuit round the north pole in 1740 years; *b* in 860; A round the south pole in 4609 years; *a* in 1304 *.

These four points of convergence, the author supposes to originate in two magnetic axes, a stronger and a weaker, in the interior of the earth. No competent data exist for estimating their position, magnitude, or relative force: a variety of approximations are attempted, however; and a method, incapable of abridgment, and much too long for insertion here, is exhibited for computing the variation, dip, and intensity, at any point of the earth's surface,—by giving to the unknown quantities such values as lead to the most accurate conclusions. The calculated results coincide pretty exactly with those of observation; and the general hypothesis appears to represent the phenomena with a degree of fidelity hardly to be expected, when the simplicity of the former is contrasted with the intricacy of the latter. A far stricter and more extensive scrutiny will, of course, be required to establish the theory on firm foundations; yet the facts it actually embraces are numerous, and in some cases explained with considerable elegance and success.

The circumstances attending the intensity and dip are none of them inconsistent with the supposition of two magnetic axes, having their extremities severally directed to the stronger points

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* The following Table exhibits their respective positions, calculated from the above data, for the first half of this century. The latitudes are most dubious.

Year.	Point B. Strongest Pole in North Hemisphere.		Point A. Strongest Pole in South Hemisphere.		Point *b*. Weakest Pole in North Hemisphere.		Point *a*. Weakest Pole in South Hemisphere.	
	Distance from the Pole.	Longitude from Greenwich.	Distance from the Pole.	Longitude from Greenwich.	Distance from the Pole.	Longitude from Greenwich.	Distance from the Pole.	Longitude from Greenwich.
1800,	20° 7′	266° 27′	20° 53′	134° 8′	4° 35′	131° 43′	12° 10′	229° 32′
1810,	20 15	268 32	21 1	133 21	4 42	135 54	11 57	226 46
1820,	20 22	270 36	21 8	132 35	4 48	140 6	11 44	224 1
1830,	20 30	272 41	21 16	131 47	4 54	144 17	11 31	222 15
1840,	20 38	274 45	21 23	131 1	5 0	148 28	11 19	219 29
1850,	20 46	276 50	21 31	130 14	5 6	152 40	11 6	216 44

of convergence B and A, and to the weaker *b* and *a*. Nor, on the other hand, are those circumstances very decidedly favourable to such a supposition. It receives confirmation, however, from several facts connected with the variation; many older observations in the southern hemisphere are plausibly accounted for; and the earliest vicissitudes of that phenomenon, observed in Europe, correspond with the system rather strikingly. According to the principles already stated, the stronger north point B, must have lain, two centuries ago, about Behring's Strait, considerably to the westward of its present position.

"Before 1600, the north point *b* must have lain still farther to the westward of its present position, as far probably as the east coast of Greenland; for which reason, it seems likely that the easterly system of variations, which extended over Europe in 1600, lay previously more to the west. And this supposed change in the variation, brought about by the motion of that magnetic point, appears to be confirmed by several facts. The easterly variation at Paris seems to have reached its *maximum* in 1580; for in 1541, it is stated as 7° or 8°; in 1550, Orontius Finnäus found it between 8° and 9°; in 1580, it was 11° 30′; and finally, in 1603, it was 8° 45′; since which time it has continually diminished. Hence it is probable, that about the middle of the fifteenth century, the variation in Paris was 0°, and westerly before that period: in 1450, the north-east portion (which passes through Irkutsk in the present chart) of the line without variation passed over Paris; after which, the variation became easterly, attained its *maximum* in 1580, and finally vanished, because the north-west portion (near Casan in the present chart) of the same line went over Paris in 1666. As the north point *b* moved eastwards, the whole easterly system of variations in Europe followed it, and is now to be found in Siberia: the north point B also approached Europe slowly, and occasioned an augmenting westerly variation, which, however, for the same reason, will subsequently diminish. In the United States of America, the westerly variation must needs decrease, for the point B is withdrawing; and before another half century, the variation, for a like reason, will become westerly."

From the secular inequalities of the magnet, Mr Hansteen turns to its daily and hourly inequalities; and the last chapter includes a copious account of the principal experiments directed to this object. The essential part of the conclusions deduced from his own investigations, those of Graham, Canton, Hiorter, and others, is contained in the following extract.

"In addition to its annual movement, the needle has likewise a sensible movement from day to day, and even from hour to hour. In Europe, it lies farthest to the east about 8 or 9 o'clock in the morning, farthest to the west about 1 or 2 o'clock in the afternoon; it next travels back eastward till about 8 or 9 o'clock in the evening, when it continues stationary for an hour or two, or else makes a slight recoil towards the west; during the night it commonly advances a little eastward, so that about 8 in the morning it is found somewhat more easterly than it was the preceding evening.

"Besides this regular daily oscillation, there happen at times on a sudden, large extraordinary movements, in which the needle traverses, frequently with a shivering motion, an arc of several degrees on both sides of its usual position. Those appearances are seldom, perhaps never, exhibited, unless when the aurora borealis is visible; and this disturbance of the needle seems to operate at the same time in places the most widely separated. The extent of such extraordinary movements may, in less than twenty-four hours, amount to 5° or 5½°. In such cases the disturbance is also communicated to the dipping needle, and so soon as the crown of the aurora quits the usual place (the points where the dipping needle produced would meet the sky,) that instrument moves several degrees forward, and seems to follow it. After such disorders, the mean variation of the needle is wont to change, and not to recover its previous magnitude till after a new and similar disturbance.

"The common daily movement about the summer solstice, is nearly twice as great as about the winter solstice: at the former season about $\frac{1}{4}$, at the latter $\frac{1}{8}$ of a degree. There is likewise a regular monthly movement, such as that from the summer solstice to the vernal equinox, the needle travels westward; eastward from the vernal equinox to the summer solstice.

"The regular daily movement is smaller near the equator, and increases onward to the pole. The needle's eastermost or westermost position does not happen at the same instant, nor even at the same hour, in places very distant from each other. Its westermost position is reached in Iceland and Greenland, at from eight to 10 in the evening; in Europe and the American United States, from two to three in the afternoon; in Sumatra about seven in the morning, in St Helena about eight. Its eastermost position is attained in Europe and North America about seven or eight in the morning, in Iceland and Greenland about nine or ten; in Sumatra about five in the evening, at St Helena, about six (or two). On the north-west coast of America, the westermost position seems to occur in the forenoon, the eastermost in the afternoon.

"Those daily oscillations, in fine, appear to consist of four movements, two directed eastward, two westward. During the continuance of the aurora borealis, the intensity of the earth's magnetic force seems to grow weaker, for which reason the needle recedes from that magnetic pole where the ring of the aurora is displayed."

The facts now glanced at on the subject of terrestrial magnetism, are calculated to inspire an active curiosity as to their origin. Nearly all of them shew symptoms of a metallic nucleus existing in the earth's interior, over which the magnetic virtue is diffused, according to certain obscure and complicated laws. Mr Hansteen has successfully demonstrated the inconsistency of supposing with Euler, that one magnetic axis is sufficient to account for all: but whether the hypothesis of two magnetic axes shall be found more agreeable to nature, is not so easily determined. And, at all events, the question concerning the cause of their movement will even then be as far from a solution as ever. Halley's conjecture assigning a motion to the nucleus itself, was not only highly improbable, but also inapplicable to the facts: and as we naturally suppose the nucleus to be immoveable, it appears most rational to seek the operating principle in something exterior to the earth. Mr Hansteen inclines to refer this agency to the sun and moon, as the bodies which lie nearest to us, and produce the strongest impression on our globe. Nor is he without arguments to support this opinion. They are grounded on a variety of facts, curious, though not convincing. One of the most singular is deduced from the correspondence of his magnetic periods with certain remarkable numbers, to be found in the Greek and Oriental astronomy. We stated already, that 860, 1304, 1740, 4609 years are the times respectively in which the four points of convergence are supposed to perform their revolution round the north and south poles. By a slight alteration, those numbers become 864, 1296, 1728, 4320, or 2×432, 3×432, 4×432, 10×232. Now, among the sacred numbers of the Indians, Babylonians, Greeks and Egyptians, said to depend on certain combinations of natural events, this 432 seems to be one of the most important *. According to the Brahminical mythology, the world's duration is divided into four periods, the first equal to 432,000 years, the second $2 \times 432{,}000$, the third $3 \times 432{,}000$, the fourth $4 \times 432{,}000$,—in all, $(1 + 2 + 3 + 4$, or $10) \times 432{,}000$. It is farther worthy of remark, that the sun's mean distance from the earth is 216 (or $\frac{432}{2}$) radii of the sun; the moon's mean distance 216 radii of the moon: and, what is still more striking, $60 \times 432 = 25920$, the smallest number divisible at once by all the four periods; and hence the shortest time in which all the four points can accomplish a cycle and return to the same state as at first, *coincides exactly with the period in which the precession of the equinoxes will amount to a complete circle,* reckoning that precession at one degree in seventy-two years, as observation requires.

Pursuing the idea of magnetism being connected with astronomy, Mr Hansteen afterwards observes: "As to the origin of those magnetic axes, we may suppose them either to have been produced along with the earth itself, or at a later epoch. According to the first hypothesis, no cause for their change of position is discoverable; according to the last, they must either have resulted from the earth *alone* or from some *exterior force.* If the axes sprung from the interior energy of the earth itself, their change of position still seems hardly susceptible of explanation, and the tendency to unite manifested by the opposing forces, points to a strong outward excitement as requisite for separating them, even granting such a separation to be possible. For these reasons, it appears most natural to seek their origin in the sun, the source of all living activity; and our conjec-

* Schubert.

ture gains probability from the preceding remarks on the daily oscillations of the needle. Upon this principle, the sun may be conceived as possessing one or more magnetic axes, which, by distributing the force, occasion a magnetic difference in the earth, the moon, and all those planets, whose internal structure admits of such a difference. Yet, allowing all this, the main difficulty seems not to be overcome, but merely removed from the eyes to a greater distance; for the question may still be asked with equal justice: *Whence did the sun acquire its magnetic force?* And if from the sun we have recourse to a central sun, and from that again to a general magnetic direction throughout the universe, having the milky-way for its equator, we but lengthen an unrestricted chain, every link of which hangs on the preceding link, no one of them on a point of support. All things considered, the following mode of representing the subject, appears to me most plausible. If a single globe were left to move alone freely in the immensity of space, the opposite forces existing in its material structure would soon arrive at an equilibrium conformable to their nature, if they were not so at first, and all activity would soon come to an end. But if we imagine another globe to be introduced, a mutual relation will arise between the two; and one of its results will be a reciprocal tendency to unite, which is designated and sometimes thought to be explained by the merely descriptive word, attraction. Now, would this tendency be the only consequence of that relation? Is it not more likely that the fundamental forces being driven from their state of indifference or rest, would exhibit their energy in all possible directions, giving rise to all kinds of contrary action? The electric force is excited, not by friction alone, but also by contact, and probably also, though in smaller degrees, by the mutual action of two bodies at a distance,—for contact is nothing but the smallest possible distance, and that, moreover, only for a few small particles. Is it not conceivable that magnetic force may likewise originate in a similar manner? When the natural philosopher and the mathematician pay regard to no other effect of the reciprocal relation between two bodies at a distance, except the tendency to unite,—they proved logically, if their investigations require nothing more than a moving power; but should it be maintained that no other energy *can* be developed between two such bodies, the assertion will need proof, and the proof will be hard to find.

"I reckon it possible, therefore, that by means of the mutual relations subsisting between the sun and all the planets, as well as between the latter and their satellites, a magnetic action may be excited in every one of those globes whose material structure admits of it,—in a direction depending on the position of the rotatory axis with regard to the plane of the orbit. Each of the planets might thus give rise to a particular magnetic axis in the sun; but as their orbits make only small angles with the sun's equator and each other, those magnetic axes would, perhaps, on the whole, correspond with the several rotatory axes. Such planets as have no moons would, on this principle, have but one magnetic axis; the rest would, in all cases, have one axis more than they have moons; if those different axes, by reason of the small angles which the orbits of their several moons form with each other, did not combine into a single axis. The conical motions by which the rotatory axes of the planets are carried round the pole of the ecliptic, (the precession in the earth,) joined to the revolving motion of the orbits about the sun's equator, (which occasions the present diminution in the obliquity of the ecliptic,) might perhaps, in this case, account for the change of position in the magnetic axis. It would greatly strengthen this hypothesis, if the above great magnetic period, after the lapse of which both axes again assume the same position, should in fact be found to coincide with the period of the precession, which, however, seems a little doubtful."

Perhaps the speculation just quoted, may seem more comprehensive than profound; it was given as a conjecture, and is nothing more. In fact, beyond the mere elements, the whole science is involved in conjecture, and after all that has been attempted and achieved, we may still conclude, with a slight change, in the words of old Purchas, assumed by Mr Hansteen as a motto: "This magnetical virtue was hidden to the golden and silver ages, her iron sympathie has long been known to the iron world; but her constant polar ravishments, and her no less constant inconstancies by variation, were (and still continue,) mysteries reserved to later posterities."

Art. XVIII.—*Historical Account of Discoveries respecting the Double Refraction and Polarisation of Light.* (Continued from Vol. III. p. 285.)

Period III.—*Containing the Investigations of Newton, Beccaria, Martin, Haüy, Wollaston, and La Place.*

Sect. I.—*Account of the Investigations of Sir Isaac Newton.*

The only observations which Sir Isaac Newton appears to have published on the subject of double refraction and polarisation, are contained in the Queries printed at the end of the 3d Book of his *Optics*. As they are written with great perspicuity, and easily understood, we shall lay them before our readers in his own words.

" *Query* 25. Are there not other original properties of the rays of light, besides those already described? An instance of another original property we have in the refraction of Iceland Crystal, described first by Erasmus Bartholine, and afterwards more exactly by Hugenius, in his book De la Lumiere. This crystal is a pellucid fissile stone, clear as water or crystal of the rock, and without colour; enduring a red heat without losing its transparency, and in a very strong heat calcining without fusion. Steeped a day or two in water, it loses its natural polish. Being rubbed on cloth, it attracts pieces of straws and other light things, like amber or glass; and with aqua fortis it makes an ebullition. It seems to be a sort of talc, and is found in form of an oblique parallelopiped, with six parallelogram sides and eight solid angles. The obtuse angles of the parallelograms are each of them 101° 52′; the acute ones 78° 8′. Two of the solid angles opposite to one another, as C and E, (See Plate III. Fig. 3.) are compassed each of them with three of these obtuse angles, and each of the other six with one obtuse and two acute ones. It cleaves easily in planes parallel to any of its sides, and not in any other planes. It cleaves with a glossy polite surface not perfectly plane, but with some little unevenness. It is easily scratched, and by reason of its softness it takes a polish very difficultly. It polishes better upon polished looking-glass than upon metal, and perhaps better upon pitch, leather or parchment. Afterwards it must be rubbed with a little oil or white of an egg, to fill up its scratches; whereby it will become very transparent and polite. But for several experiments, it is not necessary to polish it. If a piece of this crystalline stone be laid upon a book, every letter of the book seen through it will appear double, by means of a double refraction. And if any beam of light falls either perpendicularly, or in any oblique angle upon any surface of this crystal, it becomes divided into two beams, by means of the same double refraction. Which beams are of the same colour with the incident beam of light, and seem equal to one another in the quantity of their light, or very nearly equal. One of these refractions is performed by the *usual* rule of optics, the sine of incidence out of air into this crystal being to the sine of refraction, as *five* to *three*. The other refraction, which may be called the unusual refraction, is performed by the following rule,

"Let ADBC represent the refracting surface of the crystal, C the biggest solid angle at that surface, GEHF the opposite surface, and CK a perpendicular on that surface. This perpendicular makes with the edge of the crystal CF, an angle of 19° 3′. Join KF, and in it take KL, so that the angle KCL be 6° 40′, and the angle LCF 12° 23′. And if ST represent any beam of light incident at T in any angle upon the refracting surface ADBC, let TV be the refracted beam determined by the given proportion of the sines five to three, according to the usual rule of optics. Draw VX parallel and equal to KL. Draw it the same way from V in which L lieth from K; and joining TX, this line TX shall be the other refracted beam carried from T to X, by the unusual refraction.

"If, therefore, the incident beam ST be perpendicular to the refracting surface, the two beams TV and TX, into which it shall become divided, shall be parallel to the lines CK and CL; one of those beams going through the crystal perpendicularly, as it ought to do by the usual laws of optics, and the other TX by an unusual refraction diverging from the perpendicular, and making with it an angle VTX of about $6\frac{2}{3}$°, as is found by experience. And hence, the plane VTX, and such like planes which are parallel to the plane CFK, may be called the planes of perpendicular refraction. And the coast towards which the lines KL and VX are drawn, may be called the coast of an unusual refraction.

" In like manner, crystal of the rock has a double refraction: but the differences of the two refractions is not so great and manifest as in Iceland crystal.

" When the beam ST incident on Iceland crystal, is divided into two beams TV and TX, and these two beams arrive at the farther surface of the glass; the beam TV, which was refracted at the first surface after the *usual* manner, shall be again refracted entirely after the *usual* manner at the second surface; and the beam TX, which was refracted after the *unusual* manner in the first surface, shall be again refracted entirely after the *unusual* manner in the second surface; so that both these beams shall emerge out of the second surface in lines parallel to the first incident beam ST.

" And if two pieces of Iceland crystal be placed one after another, in such manner that all the surfaces of the latter be parallel to all the corresponding surfaces of the former: The rays which are refracted after the *usual* manner in the first surface of the first crystal shall be refracted after the *usual* manner in all the following surfaces; and the rays which are refracted after the *unusual* manner in the first surface, shall be refracted after the *unusual* manner in all the following surfaces. And the same thing happens, though the surfaces of the crystals be any ways inclined to one another, provided that their planes of perpendicular refraction be parallel to one another.

And, therefore, there is an original difference in the rays of light, by means of which some rays are, in this experiment, constantly refracted after the usual manner, and others constantly after the unusual manner: For if the difference be not original, but arises from new modifications impressed on the rays at their first refraction, it would be altered by new modifications in the three following refractions; whereas it suffers no alteration, but is constant, and has the same effect upon the rays in all the refractions. The unusual refraction is therefore performed by an *original* property of the rays. And it remains to be inquired, whether the rays have not more original properties than are yet discovered.

"*Qu.* 26. Have not the rays of light several sides, endued with original properties? For if the planes of perpendicular refraction of the second crystal, be at right angles with the planes of perpendicular refraction of the first crystal, the rays which are refracted after the usual manner in passing through the first crystal, will be all of them refracted after the unusual manner in passing through the second crystal; and the rays which are refracted after the unusual manner in passing through the first crystal, will be all of them refracted after the usual manner in passing through the second crystal. And, therefore, there are not two sorts of rays differing in their nature from one another, one of which is constantly and in all positions refracted after the usual manner, and the other constantly and in all positions, after the unusual manner. The difference between the two sorts of rays in the experiment mentioned in the 25th question, was only in the positions of the sides of the rays to the planes of perpendicular refraction. For one and the same ray is here refracted sometimes after the usual, and sometimes after the unusual manner, according to the position which its sides have to the crystals. If the sides of the ray are posited the same way to both crystals, it is refracted after the same manner in them both: But if that side of the ray which looks towards the coast of the unusual refraction of the first crystal be 90° from that side of the same ray which looks towards the coast of the unusual refraction of the second crystal, (which may be effected by varying the position of the second crystal to the first, and by consequence to the rays of light,) the ray shall be refracted after several manners in the several crystals. There is nothing more required to determine whether the rays of light which fall upon the second crystal, shall be refracted after the usual or after the unusual manner, but to turn about this crystal, so that the coast of this crystal's unusual refraction, may be on this or on that side of the ray. And therefore every ray may be considered as having four sides or quarters, two of which opposite to one another incline the ray to be refracted after the unusual manner, as often as either of them are turned towards the coast of unusual refraction;

and the other two, whenever either of them are turned towards the coast of unusual refraction, do not incline it to be otherwise refracted than after the usual mannrr. The two first may therefore be called the sides of unusual refraction. And since these dispositions were in the rays before their incidence on the second, third and fourth surfaces of the two crystals, and suffered no alteration (so far as appears) by the refraction of the rays in their passage through those surfaces, and the rays were refracted by the same laws in all the four surfaces; it appears that those dispositions were in the rays originally, and suffered no alteration by the first refraction, and that by means of those dispositions the rays were refracted at their incidence on the first surface of the first crystal, some of them after the usual, and some of them after the unusual manner, according as their sides of unusual refraction were then turned towards the coast of the unusual refraction from that crystal, or sideways from it.

"Every ray of light has therefore two opposite sides, originally endued with a property on which the unusual refraction depends, and the other two opposite sides not endued with that property. And it remains to be enquired, whether there are not more properties of light by which the sides of the rays differ, and are distinguished from one another.

"In explaining the difference of the sides of the rays above mentioned, I have supposed that the rays fall perpendicularly on the first crystal. But if they fall obliquely on it, the success is the same. Those rays which are refracted after the usual manner in the first crystal, will be refracted after the unusual manner in the second crystal, supposing the planes of perpendicular refraction to be at right angles with one another, as above, and on the contrary.

"If the planes of the perpendicular refraction of the two crystals be neither parallel nor perpendicular to one another, but contain an acute angle, the two beams of light which emerge out of the first crystal, will be each of them divided into two more at their incidence on the second crystal. For in this case the rays in each of the two beams will some of them have their sides of unusual refraction, and some of them their other sides turned toward the coast of the unusual refraction of the second crystal."

"To explain the unusual refraction of Iceland crystal by pression or motion propagated, has not hitherto been attempted (to my knowledge) except by Huygens, who for that end supposed two several vibrating mediums within that crystal. But when he tried the refractions in two successive pieces of that crystal, and found them such as is mentioned above, he confessed himself at a loss for explaining them. For pressions or motions, propagated from a shining body through an uniform medium, must be on all sides alike; whereas by those experiments it appears, that the rays of light have different properties in their different sides. He suspected that the pulses of æther in passing through the first crystal might receive certain new modifications, which might determine them to be propagated in this or that medium within the second crystal, according to the position of that crystal. But what modifications those might be he could not say, nor think of any thing satisfactory in that point *. And if he had known that the unusual refraction depends, not on new modifications, but on the original and unchangeable dispositions of the rays, he would have found it as difficult to explain how those dispositions which he supposed to be impressed on the rays by the first crystal, could be in them before their incidence on that crystal; and in general, how all rays emitted by shining bodies, can have those dispositions in them from the beginning. To me, at least, this seems inexplicable, if light be nothing else than pression or motion propagated through æther."

Observations on Sir Isaac Newton's Rule of Double Refraction.

Those who have already examined the Law of Double Refraction, as given by Huygens, and its agreement with observations made in all sections of the crystal of Iceland-spar, must experience no small degree of surprise, when they find that Sir Isaac Newton has proposed another law, different from his, and absolutely incompatible with observation. As Sir Isaac remarks that Huygens has described the phenomena more

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* "Mais pour dire comment cela se fait, je n'ay rien trouvé jusqu' ici qui satisfasse."—C. Huygens, *De la Lumiere*, c. v. p. 91.

exactly than Bartholinus, there is reason to believe that he made some experiments on the subject, which confirmed those of Huygens; and yet it is strange, that, without assigning any reasons, he should reject Huygens's law, and substitute another, entirely inconsistent with the very experiments he has praised. Unaccountable as this is, it is by no means uninstructive, and holds out a useful lesson to the vain admirers of human genius. In his speculations respecting the cause of the disappearance and reappearance of the pencil, when light is transmitted through two rhombs of calcareous-spar, Newton has been more fortunate; and he has undoubtedly the merit of having first suggested the idea of the *polarity* of light, and of having ascribed the phenomena of the polarisation of the pencils in Iceland-spar to original properties possessed by different sides of the rays.

Sect. II.—*Account of the Experiments of* Beccaria.

A paper, entitled, "*An Account of the Double Refractions in Crystals,*" by Father John Beccaria, Professor of Experimental Philosophy at Turin, was read before the Royal Society of London on the 18th March 1762, and printed in the Transactions for that year, vol. lii. p. 486. The principal result of these experiments is, that the double refraction in rock-crystal is greatest when the ray is perpendicular to the axis of the crystal, and that the images approached to coincidence as the ray approached to that axis. This conclusion must be considered as of some importance, as it overturns the peculiar law of double refraction which Huygens had devised for rock-crystal alone, (see Vol. III. p. 28.) According to this law, the double refraction of rock-crystal should be the same in every direction; whereas Beccaria has proved that it diminishes as the ray approaches to the axis.

Beccaria's paper is concluded with some unimportant queries, in one of which he conjectures, that the examination of the double refraction of different crystals may lead to the determination of their structure and mode of formation.

(To be continued.)

Art. XIX.—*Account of Comptonite, a New Mineral from Vesuvius.* By David Brewster, LL. D., F. R. S. Lond. and Sec. R. S. Edin. &c. &c.

Among a number of minerals which Mr Heuland was so kind as to send me in 1818, for the purpose of optical examination, there was one from Vesuvius, which he named *Apophyllite? New*, and which I find has been considered as an apophyllite by other mineralogists. As I had previously investigated the optical structure of the different Apophyllites from Iceland, Faroe, Uton, and Fassa, I was prepared for the examination of this mineral, and soon convinced myself that it was a new species allied to the Mesotypes.

Having subsequently learned that this substance was obtained in Italy a few days after its discovery, and was first brought to England by Earl Compton, I gave it the name of *Comptonite*, as a mark of respect to a nobleman whose mineralogical knowledge, and ardent zeal for the advancement of the science, have placed him in the chair of the Geological Society of London *.

Crystallographic Structure.—Comptonite is found in small transparent or semi-transparent crystals, lining the cavities of an amygdaloidal rock from Vesuvius †. The crystals which I have examined, have the form of right prisms, nearly rectangular, with plane summits; or the same figure truncated on the lateral edges, so as to compose an eight-sided prism. This last form is the most common; but though some of the crystals are very perfect and beautiful, yet there is such an irregularity on the faces of the prism, that it is impossible to obtain very precise measurements of the angles. The following are the angles which I obtained, (see Plate III. Fig. 4.)

* This mineral was first found by Salvator Madonna, the principal guide to Mount Vesuvius, in the month of September 1817. Mr Allan suggested to me the propriety of the name which I have adopted.

† In some of Earl Compton's specimens, it is accompanied with Acicular Arragonite.

a upon *b*	137° 56′	*e* upon *f*	135° 36′
b —— *c*	132 41	*f* —— *g*	135 36
a —— *c*	90 37	*e* —— *g*	91 12
c —— *d*	131 24	*g* —— *h*	132 51
d —— *e*	138 34	*h* —— *a*	135 36
c —— *e*	89 58	*g* —— *a*	88 27

In some crystals, the faces *c*, *g*, are extinguished by the truncations *b*, *d*; *h*, *f*; and in several crystals, I have observed with the microscope very slight but distinctly marked truncations on the terminal edges *b*, *d*, *f*, *h*, whose incidence upon the summit *m n* is 99°, and upon the faces 171°.

The summit plane *m n* is often a little rounded, and sometimes composed of two planes *m*, *n*, whose mutual inclination is 179°, 178°, or 177°.

The measurements of other crystals indicate very unequivocally that the prism is rectangular; but all of them make the inclination of some of the truncations so high as 137½°. If the prism should turn out to have a rhombic base, its angles cannot exceed 90° 51′ and 88° 9′.

Comptonite belongs to the Prismatic System of Mohs.

Optical Structure.—Comptonite has two axes of double refraction, one of which is parallel, and the other perpendicular, to the axis of the prism. It consequently gives the double system of coloured rings. The inclination of the resultant axes, or diameters of no polarisation, is nearly 56°; or they are inclined about 28° each to a line at right angles to the faces *a*, *e*, which is the *principal* axis of the crystal. The action of this axis is *positive*, like that of *Topaz*. The plane passing through these resultant axes is perpendicular to the axis of the prism. The index of refraction is 1.553, when the ray passes through *a* and *f*, and no separation of the images can be seen; but through *a* and *m n*, the images may be distinctly separated.

Chemical Character.—*Comptonite* is converted into a jelly, like all the mesotypes, by exposing it in the state of powder to the action of nitric acid. When a whole crystal is placed in nitric acid, it does not swell out like Apophyllite and Auvergne mesotype.

Mineralogical Character.—It scratches Stilbite, Fluor-spar, and Apatite, but not Mesotype, and will therefore have a hardness of about 5.1 in Mohs' scale. It belongs to the Second Class, and the Sixth Order, or that of Spar, and to the Genus Kouphone-spar of Mohs.

Distinctive Characters.—Comptonite is distinguished from *Stilbite*, by its being convertible into a jelly by nitric acid, a property not possessed by Stilbite;—by the inclination of its resultant axes, which is 56°, whereas that of Stilbite is 41°, and by the form of its crystals. It is distinguished from *Auvergne Mesotype*, and from the *Mesotype* or *Needlestone of Iceland*, by the angles of the primitive prism, and by the position of the plane of the resultant axes, which in these minerals passes through, or is parallel with the axis of the prism; whereas in Comptonite, it is at right angles to that axis. It is distinguished from the real *Nadelstein from Faroe*, (which I have ascertained to be a new mineral), by the angles of the primitive prism, and by other characters which will be pointed out in another paper. It is distinguished from all the *Apophyllites*, by numerous characters, but particularly by the singularity of their action upon light; and by the circumstance of the Apophyllites belonging to an entirely different system of crystallization, viz. the Pyramidal system of Mohs, whereas Comptonite belongs to the Prismatic system.

EDINBURGH, *October* 18. 1820.

ART. XX.—*Observations on Bees, made by means of the Mirror-Hive.* By the Reverend WILLIAM DUNBAR, Minister of Applegarth. In a Letter to the Very Reverend Principal BAIRD, communicated to Professor JAMESON.

DEAR SIR,

BEING desirous of ascertaining the consequence of introducing a stranger queen into a hive, without removing the reigning one, I procured from my neighbour, the Minister of Tundergarth, a small second swarm, and added it, with its queen, to the swarm already in the hive. I had no doubt that one of the queens would be sacrificed for the public good; but I wished to ascertain, whether, as Huber states, these great personages decide the matter by single combat, or whether the bees themselves destroy the supernumerary ruler. I noted down at the moment, by way of journal, the circumstances as they occurred, and I transcribe them in the same form.

July 28.—10 o'clock A. M. Put into the mirror-hive a swarm from Tundergarth Manse. During the bustle of the entry, the old queen has hid herself; the new queen is seized by a few of the old bees, the rightful inhabitants, and is in imminent danger; is rescued by a crowd of her own subjects, who treat her with much respect, and form an open circle round her, as if to defend her. A partial engagement between the swarms.

Afternoon. The battle has ceased, and the bees seem united. One queen, which I believe to be the young one, is surrounded closely by about 100 bees; no appearance of the other.

29th.—Morning. One queen on the opposite side of the comb from where the stranger one was yesterday, and closely confined; the other walking among the bees at perfect liberty; cannot ascertain which is the old one, and which the stranger; should have marked the latter before introducing her. Opened the hive, in order to bring the queens into view of each other: both escape to the other side of the comb, and *both* closely encircled by dense crowds of bees.

12 o'clock. Both still remain encircled. Opened the hive again, and seized a queen from amongst a great number of bees, not one of which attempted to sting, though, in my eagerness, I had neglected to cover my face and hands; put the prisoner into a glass tumbler, and clapped it above the circle where the other queen was; from the inequality of the comb's surface, one escaped, and was instantly surrounded; took off the tumbler, and the other instantly received the same treatment.

Afternoon. One queen close prisoner, the other at liberty, and sometimes within two inches of her rival, but without any appearance of anxiety to get at her. The crowd is pressing so very closely round the captive queen, that in all probability she will be suffocated or starved.

Evening. Matters remain in the same state.

30th. The prisoner queen on the same spot; the other at large.

Afternoon. The captive removed to the distance of twelve inches from her former station, but still vigorously confined; dispersed the cluster, and set her at liberty; but, alas! her liberty was of short date; she ran about six inches, hotly pursued by her jailors, and was again seized and surrounded as before. During her confinement, she emits almost unceasing cries, resembling the *peep, peep,* emitted by a queen previously to her leading off a second swarm, but wanting its regularity. The reigning queen does not seem to notice that she has a rival; shews none of those symptoms of rage and jealousy which Huber speaks of; but walks about very composedly, and shews no desire to break through the inclosure, to attack her rival. I observe, however, she is not laying eggs; probably her instinct is affected by the convulsed state of her empire.

31st. 9 o'clock A. M. The captive queen in the same situation, hemmed in by her cruel persecutors; opened the hive again, and dispersed the cluster of jailors, but in vain; the poor prisoner made a strong and desperate effort to escape, but had not fled two inches, when she was again arrested, and every limb held hard and fast. Resolve to remove her in the afternoon; the reigning queen has begun to lay eggs.

Afternoon. The captive queen is dead. On surveying the state of matters this afternoon, I saw her still imprisoned; opened the hive, with the intention of taking her away; dispersed the crowd, which almost totally concealed her, and found her quite dead,—a victim to my own curiosity, in the first instance, and to the jealousy of a prudent people, who seemed to know that a divided empire would not conduce to the public interest.

It appears from this experiment, that in some instances, at least, the bees themselves, contrary to the opinion of Huber, take upon them the task of dispatching a supernumerary queen; not, indeed by their stings, for I never saw one made use of on the occasion, but by suffocation or hunger. On the closest examination, I could not discern the slightest inclination on the part of either queen to decide the matter by single combat. They seemed, in fact, to be totally unconscious of each other's presence, for the reigning queen walked past the crowd which guarded her rival with great composure, seeming neither to court nor to shun the mortal strife.

A singular circumstance has taken place in this hive since the introduction of the stranger swarm, which, while it has given me much pleasure, as verifying an extraordinary fact in the natural history of this wonderful insect, presents, at the same time, a difficulty which I am unable to solve. The fact to which I allude is, that bees have the power, when deprived of their queen, of rearing an artificial one from a common worm, provided it be under three days old. In this process, they enlarge the original cell which contains the selected worm, by demolishing the three which surround it, and supply the larva with food in greater quantity, and probably of a different quality, from that which nourishes the common brood. By this treatment, naturalists say that the ovaries,—for all the working bees are females,—are expanded and developed, and the insect comes forth in due time, not as originally intended, to earn her bread by the sweat of her brow, but to assume all the honours of majesty, and to become the mother of a numerous race. This extraordinary fact I have had an opportunity unexpectedly of realizing.

When I introduced the stranger swarm with their queen into the mirror-hive, I expected, agreeably to the experiments detailed by Huber, that the two rivals, each of whom can " bear, like the Turk, no rival near her throne," would decide by duel which should retain the honours and privileges of royalty. I contemplated also the possibility of both falling in the conflict, —an instance of such a calamity having come to my knowledge, —and therefore, with the view of remedying this calamity, if it should occur, and thus of preventing the total destruction of the hive, I took a piece of comb from another hive, containing eggs and common worms of the proper age, and fixed it in the comb of the mirror, that the bees might, by proper treatment, convert a common worm into a royal one, and thus supply the vacant throne.

To my astonishment, as both queens were alive on the morning of the 29th, I saw the workers commence building a royal cell in this piece of comb, demolishing several cells around the one they had pitched upon, and enlarging this last, giving it a cylindrical instead of an hexagonal shape, and bestowing the most eager attention on the worm it contained. During the day, the royal abode made considerable progress; and on the 30th, in the afternoon, it extended above half an inch in perpendicular length. On the 31st, the royal cell advanced rapidly: saw the larva at the bottom of it, of a great size, and differing in appearance from a common worm, the bees very attentive in feeding her; the reigning queen passing her frequently, but taking no notice of what was going on. On this day, 1st of August, I observe the royal cell is sealed, of course eight days have elapsed since the egg was laid, and in eight days more the young queen should come forth.

Thus Schirach's famous discovery of bees having the power of converting common into royal worms, and which has never yet gained general belief, is completely verified. But here is the difficulty: All this time there were two queens in the hive. There was no want of a ruler, which has been supposed the only case in which the bees have recourse to this expedient. There is not a sufficient number of inhabitants in the hive to render emigration necessary; and if there were, it was never known that an artificial queen either led off a swarm, or was the cause of another doing so. I merely state the fact; let those who can, account for this anomalous proceeding. I shall of course watch the progress of this coming stranger, and should not be surprised if the reigning queen should make an attempt to destroy her on her coming into light. In that case, I may yet have an opportunity of witnessing a personal combat between two queens.

August 8. 8 o'clock A. M. The young queen is hatched; but short-lived has been her enjoyment of liberty, and, from all appearances, as short-lived will be her existence. Like her predecessor, she is already in "durance vile," about six inches distant from her cradle. A cluster of bees has hemmed her in as closely as possible, and only the lower half of her body is visible. She is making painful struggles to extricate her head and shoulders, and emitting the same dolorous sound as the former captive. In all probability she will experience the same fate. The reigning queen is very busy laying eggs, within an inch or two of the prisoner, but goes about her business with as much unconcern as if she knew that her subjects would of themselves soon rid her of this puny rival.

10 o'clock. As I anticipated, the fate of the young queen is decided. Her body had dropped lifeless from the surrounding circle to the bottom of the hive. It is considerably smaller in girth than the reigning queen, but as long. Her belly, which in a full grown one is of a dusky yellow, is in this rather of a pale reddish cast. Her legs, like those of the rest of the royal race, are of a dark orange colour, and her whole figure bears the unequivocal stamp of royalty, though originally destined for a plebeian station.

From this experiment, I am warranted in drawing two conclusions. The *first* is, That those naturalists are correct, who have asserted that the queen or mother-bee lays only two kinds of eggs, those of drones and of workers; that the egg which she lays in a royal cell, would, if deposited in a common one, produce a working bee; and that the egg she lays in a common cell, when hatched, can, by a peculiar mode of treatment, be converted by the bees into a queen. This fact, though to this day a matter of doubt, was ascertained years ago by our countryman Bonnar, whose acuteness led him to the very verge of the greatest discoveries that have yet been made in the natural history of bees.

The second conclusion I am authorised to draw from this experiment, militates strongly against the opinion and observations of Huber, on the combats of queens. Here were two cases, in which one, at least, of these great personages had an opportunity of shewing her prowess; but she seemed to be not at all blood-thirsty, and we must allow, that it is not consistent with the welfare of an empire, for the occupier of the throne to risk her personal safety in combating the enemies of the state.

I have great confidence in the veracity of Huber, and am satisfied he saw what he affirms, and that he saw it oftener than once; for otherwise he would not have spoken so decidedly on the subject. My experiment, however, establishes the fact, that, in some cases at least, the reigning queen leaves it entirely to the working bees to despatch her rivals.

Applegarth Manse,
21*st August* 1820.

Art. XXI.—*Description of an Apparatus for Restoring the Action of the Lungs.* By Mr John Murray, Lecturer on Chemistry. Communicated by the Author.

Every person who knows the fine movements of the lungs, and their beautiful isochronism, will wonder that the *bellows* can in any case be efficient in restoring their action. The pressure on the chest, in the ex- pulsion of the air injected by this machine, is as rude and unequal as the action of the bellows itself is variable, directed, as it often is, by the error and caprice of an unskilful hand; and even the forces will at all times be balanced with difficulty by the best directed efforts of the most dexterous operators. We have only to look at those numerous unsuccessful cases, which appeared so promising, to draw the painful conclusion, that the instrument commonly used, is quite unfit for the purpose, and that there still is a valuable *desideratum* to be accomplished.

Impressed with the magnitude of the subject, I have drawn up the following description of an apparatus, which seems calculated to supply the defect; and I am happy to say, that it has met with the decided approbation of such medical gentlemen and mechanists as I have explained it to.

Description of Fig. 8. Plate III.

A, is a cylinder, in which the piston-rod moves, having a solid piston, and passing at top through a close collar of leather.

B, the piston-rod.

C, represents a cylinder of tin, with a partition concentric with it, which partition receives water (at *a*) heated to 98° Fahr. (the animal temperature), *et infra*, and of course raises the air within the canister to the same temperature. *b*, is a canal and stop-cock connecting the air cylinder with the pump, and becoming the medium of supply. When asphyxia is occasioned by carbonic acid gas, a few drops of ammonia in the air-cylinder will be eminently serviceable, in the first instance; for unless this air be abstracted or neutralized, we shall endeavour in vain to excite the suspended energy of the lungs; and as a drop or two of ether might be occasionally useful as a stimulant, (since it appears that a mixture of etherial vapour and atmospheric air produces all the effects of nitrous oxide), it may be conveniently applied through this appendage.

D, is a bladder and stop-cock for the occasional administration of oxygen or nitrous oxide.

E, is a flexible hose, similar to that in the common apparatus, with a stop-cock to cut off or restore the communication at its entering the larynx, and *b* is a perforated tube, with a safe-shield which closes the vent, and that tube is maintained in its place by the fixation of a ribbon round the head of the victim of suspended animation.

c, is a valve resembling the key of a flute, and operating similarly; for, by pressing the farther end of the lever, the aperture is uncovered, and, by a spring, it recovers its wonted place. It serves to empty the cylinder occasionally, and prior to the re-supply of new air from the attached air-cylinder.

d, is a curved canal, uniting the space *below* the valve with that *above* it, when the piston ascends to the dotted line *g*. *f*, is a joint, by which the tube is made to slide into itself like the tubes of a telescope, and thus regulate the size of the volume of air for lungs of any required capacity.

e, is the button-valve, which is raised by the air escaping from the lungs, and filling the space prepared by the ascending piston; and the same elevation of the valve uncovers the orifice of the canal *h*, and the air rushes through it so soon as the piston-rod mounts to *g*, and fills up the space which obtains between the orifices at the dotted line *g* and the valve *e*.

From this description, the mode of using the apparatus must be evident.

Art. XXII.—*Notice of the Progress of the Arctic Land Expedition under the command of Lieutenant* Franklin. In a Letter to Professor Jameson *.

[Dear Sir, *London, November 26. 1820.*

Knowing the lively interest you take in the progress of geographical discovery, and having observed in the 1st volume of the Edinburgh Philosophical Journal a short account of the plan of the Arctic Land Expedition, I use the liberty of transmitting to you an extract from a journal dated Cumberland House, June 1. 1820, lately received from Hudson's Bay, and which brings up the progress of Lieutenant Franklin's expedition to the 1st of June last. I remain, &c.]

After leaving York Fort, the expedition ascended Hayes, Steel, and Hill Rivers, which, with a series of small lakes, and their connecting streams, form one continued line of water communication to the *Painted Stone*. Over the low rock which has obtained this name, the boats were launched into a rivulet named the Echemamis, which we descended till its junction with a branch of Nelson River. Proceeding up this branch, and passing through Play-green and Winnepeg lakes, they entered the Saskatchewan, and navigated it as far as Cumberland House, the wintering station of the expedition.

York Fort is situated on a point of alluvial land which separates the mouths of Hayes and Nelson Rivers. Throughout the whole length of Hayes River, the country has an uniform low, flat, swampy appearance. The soil consists of decayed moss, immediately under which there is a thick bed of tenacious bluish clay, containing imbedded rolled stones. The stream continually encroaching upon some points, and depositing its spoils in others, renders its banks alternately steep and shelving; but in general, the bed of the river is scooped out in this clay to the depth of thirty or forty feet. The plain above is covered with stunted larches, poplars, alders, and willows. Hayes River is formed by the junction of the Shammattwa and Steel Rivers; and the latter branch is in like manner produced by the union

* Read before the Wernerian Society, December 2. 1820.

of Fox and Hill Rivers. During the ascent of Steel River, the banks gradually increase in height; and in the lower part of Hill River, they exceed 300 feet. These high clayey banks are broken into conical hills by the deep ravines which open into the river. The travellers had no opportunity of judging of the nature of the interior; but wherever the current had worn away the bank, the section exhibited only the clay above mentioned.

About 90 miles from the sea-shore, a ridge of primitive rocks presented itself, crossing the bed of the river, and producing a fall termed the Rocky Passage. Above this spot, the banks of the Hill River gradually decrease in height, the channel continuing uniformly rocky, and at length the superincumbent clay entirely disappears, leaving the rocks on the borders of the stream either quite naked, or partially covered with soil, and clothed with trees. Eight or nine miles above the rock-portage, there is a small range of conical hills, the most remarkable of which is termed the *Hill*, and gives the name to the river. It is from 500 to 600 feet high. Above this hill, the shores were low and rocky, but the woods concealed the interior from our view. The rocks seem to be primitive; and the flatness of the country was ascribed to the abundance of the water, which, filling the valleys, generally so deep in this formation, leaves the summits of the ridges alone uncovered. Thirty-five lakes are visible from the top of the Hill. No material variety in the appearance of the land was observed before they arrived at the Painted Stone; and even after crossing into Nelson River, the same species of rock was seen exposed.

At the entrance of Lake Winnipeg, an alluvial stratum again covers the rocks to an unknown depth. It differs a little from the clay through which Hayes River runs, in being of a whiter colour, and probably in containing a considerable portion of calcareous matter. Calcareous rocks make their appearance in great abundance on the western side of Lake Winnipeg, the whole country for at least 300 miles along the course of the Saskatchewan appearing to be composed solely of them. There is a fine section of them at the Grand Rapid, near the mouth of the river. At this place, the stream forces its way through a chasm about 60 feet deep, the rocks on each side being disposed in thin strata, dipping to the northward at an angle of 10°. The rocks yield readily to the conjoined actions of the water and the atmosphere, and fall into the river in large cubical fragments, which soon separate in the direction of the strata, into layers. The prevailing colour of the stone is cream-yellow; and it appears to contain a considerable portion of clay, as it adheres to the tongue when broken. It burns into a very white lime, but it requires to be a long time exposed to the action of the fire. We could not find any other rock associated with this limestone, nor could we discover any organic remains in the rocks in their native situation; but some small fragments lying loose amongst the soil, contained shells. The banks of the Saskatchewan, for the distance above mentioned, are low and swampy, but in many places the limestone shews itself above the surface. It exhibits a surprising uniformity of appearance.

During the winter, an excursion was made to Beaver Lake, about 40 miles to the northward, and the rocks were still found to be calcareous, but of a more crystalline texture, and varying in the colour, and in the direction of the strata. On the borders of the lake, there are small hills and mural precipices of both red and yellow limestone. There are many deep rents in the rocks here, and the lake in some places is 15 fathoms deep.

To the southward of Cumberland House, there is a round-backed hill, about 40 miles long, which the expedition had not an opportunity of visiting. It is visible about 30 miles off, and exhibits an even outline; but we were told, that a near approach shews it to be rugged. There are several springs at its base, which afford a considerable quantity of *salt*.

The river was traced about 240 miles above Cumberland House to Carlton House. There the country is entirely *alluvial*, consisting of extensive sandy plains, and nearly destitute of wood. These plains, about 200 feet above the present bed of the river, appear to have been covered at no very distant date. From the summit of the plain to the river, a regular gradation of three or more banks may be traced, shewing the height at which the river has flowed at different periods. Amongst these banks, the river shifts its bed continually, encroaching, on the one side, on the deep bank of the plain, and forming low level points on the opposite shore. The older plains are dry and sandy, and produce a short grass, which supports numerous herds of buffaloes. But the newer deposites beneath the high bank, contain much more vegetable matter, and are in general overgrown by willows and poplars.

The plains do not extend far to the northward of the Saskatchewan, but they reach the base of the rocky mountains on the westward; and on the southward, their extent is very great. About ten years ago, there were numerous small lakes in the neighbourhood of Carlton; but since that time, many of them have dried up. The older people, too, repeat that the waters of the Saskatchewan have been gradually diminishing. On the face of some of the banks, there are many loose stones, precisely similar to the calcareous rocks at the mouth of the river.

Near Edmonston House, about 300 miles above Carlton House, several beds of coal are exposed, one of which was accidentally set on fire some years ago, and still continues burning.

The commander of the expedition was on the 1st June still occupied in preparing for the journey to the northward, the journey to Carlton having absorbed much time.

Art. XXIII.—*Notice of Captain* Parry's *Voyage of Discovery.* By Professor Jameson. With a Chart of Captain Parry's Discoveries in the Arctic Seas.

The memorable voyages of Davis in the years 1585, 6, and 7; of Hudson in 1610; of Baffin in 1616; and of Fox, Ellis, and Middleton, in succeeding periods, may be considered as the principal sources of the discoveries made in the countries to the northward and westward of Cape Farewell, the most southern point of West Greenland. The many considerable Sounds discovered by these navigators in Baffin's Bay and Hudson's Bay, have always been considered as objects of great geographical interest; and various circumstances have led to the opinion, that some, if not all of them, communicate with the Polar Sea, thus affording a hope of their leading to the discovery of the long-sought for North-West Passage around the northern coasts of America, through Behring's Strait, into the Great South Sea. Mr Ellis, in his interesting work, entitled, "A Voyage to Hudson's Bay," infers from the following, amongst other circum-

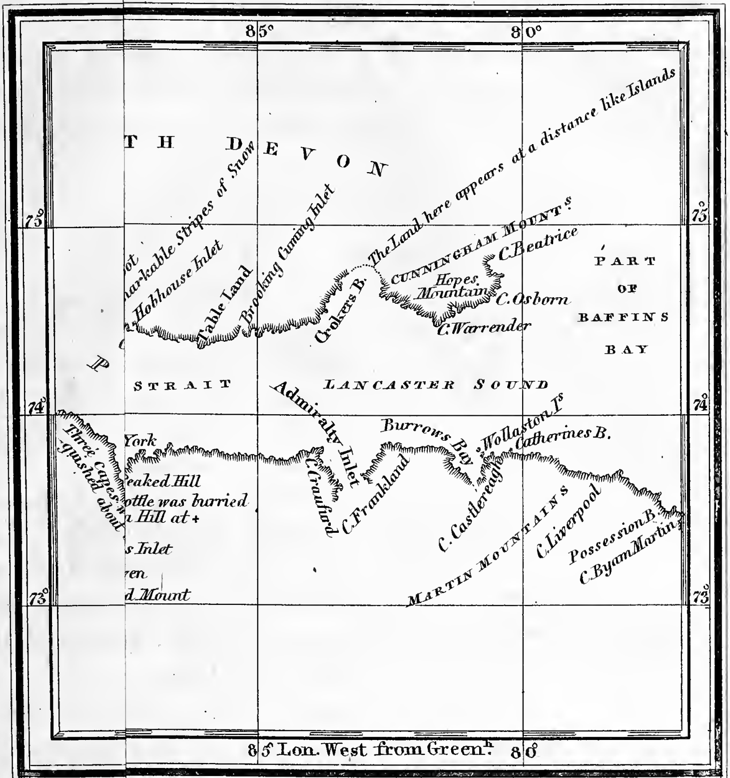
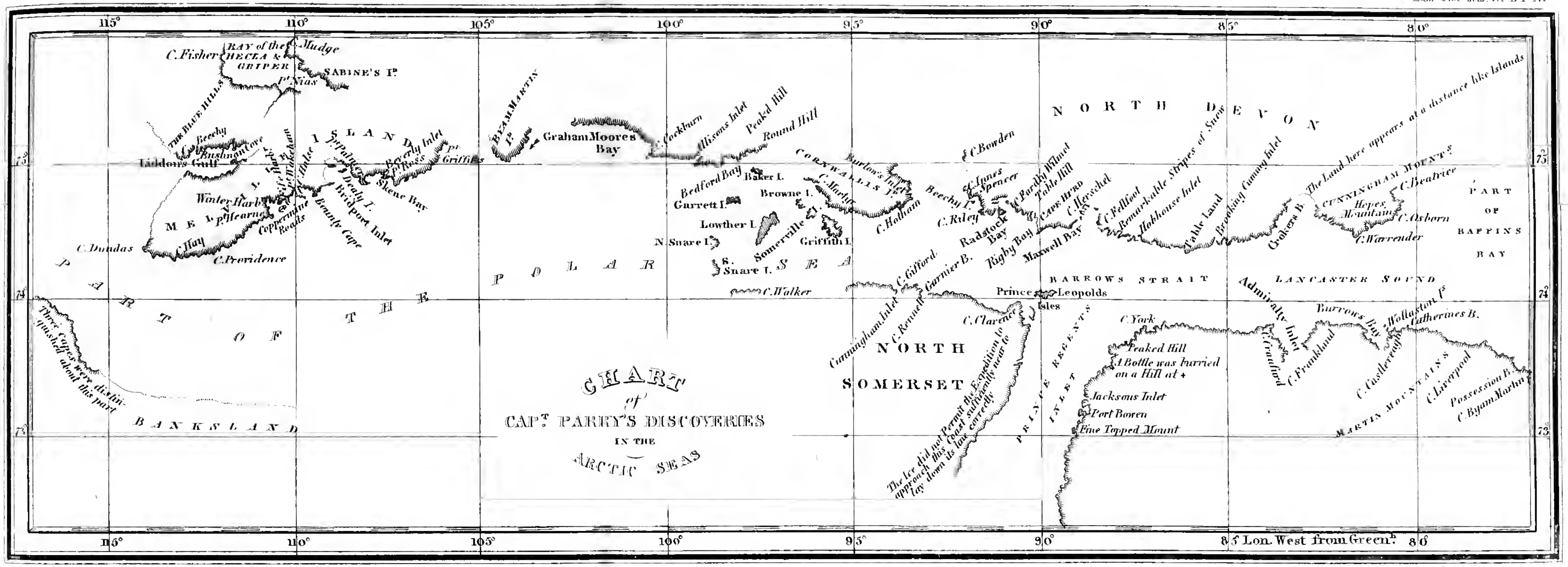
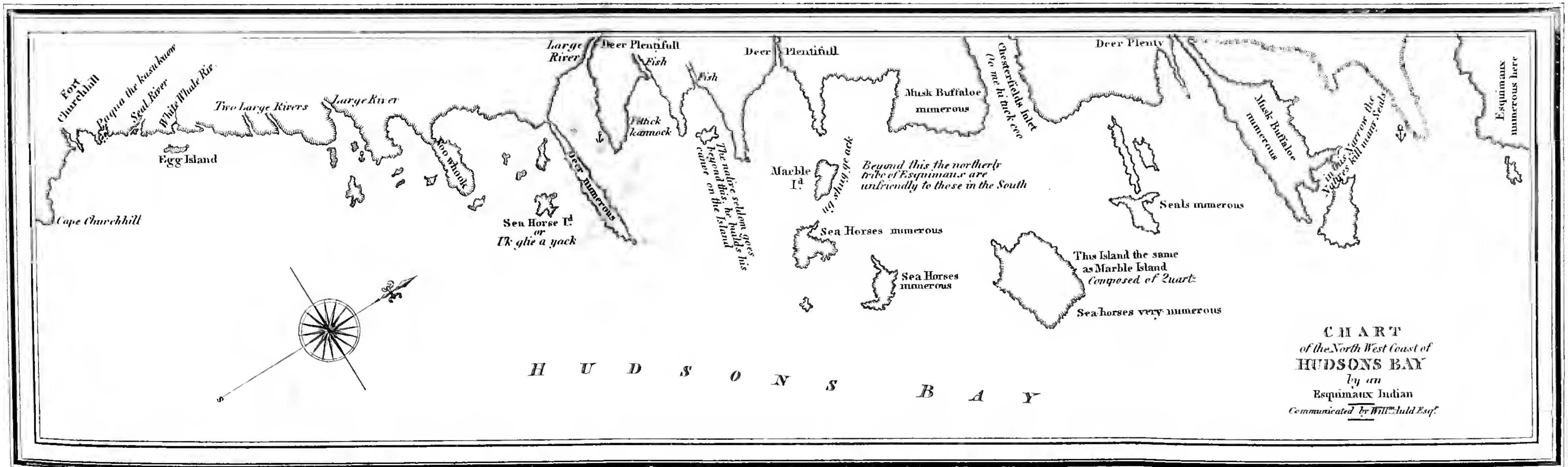


CHART
of the North West Coast of
HUDSONS BAY
by an
Esquimaux Indian
Communicated by Willm. Auld Esqr.

W.H.Lizars Sculpt.

Edin. Phil. Jour. Vol. II. P. 144





W.H.Lizars Sculpt.

Edinburgh Published by A. Constable & Co. 1820

stances, that a passage leads through some of the Sounds on the north side of Hudson's Bay into the Polar Sea; that in inland seas, having but small outlets, there is little or no tide; that in such places, what tide there is, rises highest in the inlet, where the sea is narrowest, and becomes less and less considerable, in proportion as the sea enlarges within; that the highest tides, in such situations, are occasioned by winds blowing into the inland sea, in the direction of its strait, communicating with the main ocean, or in the direction of the course of the tide on the exterior coast; and that the time of high-water is soonest at places near the entrance of the inland sea, and progressively later in other situations, according to their distance from the strait through which the tide flows. These facts he derives from observations on the winds and tides in the Baltic, Mediterranean, and other inland seas. From the application of these principles, Ellis proceeds to shew, that every circumstance with regard to the tides in Hudson's Bay, is different from what would take place in an inland sea; and then concludes, that Hudson's Bay is not such a sea, but has some opening which communicates with the Frozen Ocean on the north-west. Just within the entrance of Hudson's Strait, at Cary Swan's Nest, the tide was found by Captain Fox to rise but six feet; whereas on the west side of the bay, where, from the great expansion of the waters, the tide, according to theory, ought to have been scarcely perceptible, it rises in different places ten, thirteen, and seventeen feet. The flood-tide on the west side of Hudson's Bay flows towards the south; and the time of high-water is soonest the farthest towards the north; both of which circumstances, supposing Hudson's Bay to be an inland sea, with only one entrance from the east, should, Ellis conceives, according to the doctrine of tides, have been just the contrary. And, lastly, the highest tides on both sides of Hudson's Bay, are produced by north and north-west winds; whereas, were it an inland sea, it is clear, that east or south-east winds, blowing directly through the strait, or in the direction of the flood-tide without, would produce the highest tides. Hence he concludes, that the tide of flood flows into Hudson's Bay, through some other entrance than that called Hudson's Strait; not from Baffin's Bay either, because the tide is there inconsiderable, but from the north-west or the Icy Sea; by which conclusion all the difficulties with regard to the tides are easily solved *. This reasoning is so satisfactory, as to leave little doubt on our mind, that some of the inlets on the north coast of Hudson's Bay, particularly that named Repulse Bay, and another to the eastward of it, lead into the Polar Sea. The exploration of these inlets will, we hope, be again attempted, if it should not previously be accomplished by Lieutenant Franklin's expedition in its course eastward.

The opinion of geographers that West Greenland is probably an island, and that therefore Baffin's Bay communicates with the Arctic Ocean through some of its Sounds, is founded on a variety of circumstances, of which the following may be enumerated. 1. The existence of a current setting from the north. 2. The floating of icebergs and of drift-wood to the southward by this current. 3. The fact of whales wounded in the sea around Spitzbergen having been caught in Davis' Strait. 4. and lastly, The insular position of the land, as represented on skins by the native inhabitants of the country. These, and many other facts of the same description that might be stated, warranted geographers in their conclusions, that Baffin's Bay was not shut up to the north and west by continuous land; but, on the contrary, was connected with the Polar Sea by Sounds, and excited a strong desire that an opportunity might be offered, of enabling navigators to examine these openings with greater care than had hitherto been the case. Accordingly, the Admiralty fitted out an expedition for Baffin's Bay, placed it under the command of Captain Ross and Lieutenant Parry, and instructed them to endeavour, if possible, to make a passage from the Bay through some of the Sounds into the Polar Sea, and from thence to proceed onwards to the South Sea, through Behring's Strait †. Of this expedition, an account has been already laid before our readers in the 1st volume of this Journal, from which it appears,

* Vide Scorseby's *Arctic Regions*, and Ellis's *Voyage to Hudson's Bay.*

† Mr Barrow, the celebrated geographer and traveller, to whom the scientific world is under so many obligations, was, we understand, the person who first conceived the plan of this and also of the recent Arctic Expedition, and who, by his enlightened views and indefatigable zeal and activity, contributed most materially to the final adoption and execution of these memorable enterprizes.

that, from various untoward circumstances, several of the Sounds had not been thoroughly examined; and that although much important information resulted from Captain Ross's investigation, still the grand object of the expedition remained unaccomplished. The learned all over Europe now took a great interest in the solution of this problem, in regard to the passage from Baffin's Bay into the Polar Sea, and the enlightened government of this country having the same feeling, immediately ordered another expedition to be prepared.

Two vessels, the Hecla and Griper *, were selected and provided with every comfort and convenience for the crews, who, it was supposed, might be obliged to winter in the polar regions. The command was given to Lieutenant (now Captain) Parry, a young, active, fearless, intelligent, and accomplished officer, who was accompanied by Messrs Liddon, Beechy, and other officers, admirably fitted for the bold and dangerous enterprize on which they were about to embark. They were furnished with the best instruments for astronomical, meteorological, hydrographical, and magnetical observations; and, we doubt not, were also amply provided with every means for collecting and preserving various objects of natural history. Meteorologists expected from this expedition numerous important details in regard to the climates of regions hitherto but rarely visited, or which had not before been seen by any civilized beings; and philosophers paused in their speculations and calculations in regard to the magnetic poles and meridians, until the results of the various and important observations on the magnetism of the earth, which were to be made in regions where both theory and former experience had placed so many of the most interesting and important magnetical phenomena, should be made known. The hydrographer, too, anticipated the confirmation of many speculative views, and numerous additional facts in regard to the wa-

* As the ships of this successful expedition have only but just returned, very little is known in regard to their discoveries and observations, and therefore we once intended delaying the insertion of any notice of it in our present Number. But the wish of the public for some account, however imperfect, of the discoveries made by Captain Parry, is, we find, so pressing, that we have been induced to collect, from various sources, many of the particulars in this relation.

ters of the arctic regions; while the natural historian, embracing in his science all the varied productions of the animal, vegetable, and mineral kingdoms, felt an intense interest in the success of an enterprize, which, under fortunate circumstances of time and weather, he was confident would throw so much light, not only on the geographical and physical distribution of organized beings, but on the geognostical structure of unknown regions, and which was to furnish him with new views of arctic nature. And geographers, although confident that the passage into the Polar Sea was about to be effected, and that the expedition under Lieutenant Parry was to contribute in an eminent degree to our knowledge of the various forms and distributions of the polar lands, yet never entertained the visionary and vulgar fancy of a commercial passage into the South Sea.

All the preparations being finished, the ships took their departure from England on the 11th of May 1819. They reached Cape Farewell on the 14th of the succeeding June. On the 20th of June, the ships were in Lat. 64° N.: on the 26th of June, they were beset with the ice, and, after having endeavoured, but in vain, to urge their way, were at last glad to get back again. Having reached the Lat. of 74° N., they determined to force a passage through the barrier of ice, which they found to be 80 miles broad. Having succeeded in this, they reached Possession Bay on the 31st of July, where they landed in a rugged country, composed of granite, gneiss, and other primitive rocks; and on the 18th of August, entered in safety Sir James Lancaster's Sound, a position now become so distinguished in geography, where they found the same open sea which had been described in the account of the former expedition. They advanced to Long. 89° W. meeting with but little obstruction from the ice; and in Long. 90° W. discovered two considerable isles, named, in honour of Prince Leopold, *Leopold's Isles*. But at this point, their progress westward was interrupted by a strong barrier of ice, extending quite across from these islands to the north coast of what Captain Parry has named *Barrow's Strait*. Being thus arrested by the ice, and forced to alter their course, they now entered a great inlet, of 14 leagues in breadth, which they found extending to the southward. They sailed along its eastern side, landed in different points, and in some places met with rocks of that kind of limestone named Stinkstone, from the peculiarly fetid odour it exhales when pounded. The middle and western part of this inlet, named *Prince Regent's Inlet,* was blocked up with ice as far as Lat. 71° N. when their further progress southward also was found to be impossible, by reason of the ice *. On their return to Barrow's Strait, it was found that the barrier of ice extending across from Leopold's Isles to the north coast, had broken up, so that now the ships were enabled to pursue their course westwards. Having reached Long. 92° W., they found the land on the north side of the Strait, which had been continuous from the entrance of Sir James Lancaster's Sound, interrupted by a great inlet. Land, however, was still seen to the westward, and the expedition continued its course in that direction. In doing so, the ships passed twelve large islands, which were named the *Islands of New Georgia,* in honour of his Majesty, and all of them were apparently more or less surrounded with ice; from which circumstance, partial detentions were unavoidable, and their course ran in a sort of zig-zag style, from Lat. 74° N. to Lat. 75° N. They landed on several points on the north side of Barrow's Strait, and found in different places extensive formations of limestone, some of the varieties being white marble, others of a duller aspect, and containing petrifactions of madrepores, and other similar animal marine productions, now found only in a living state in seas far to the south, principally in the ocean between the tropics. They landed also on an island, which was named *Byam Martin's Island.* Here they met with various rocks of the primitive class, as gneiss, granite, and a variety of talc-slate, with numerous interspersed scales of brown mica. Resting on these older rocks, various newer rocks of the secondary class were met with, such as sandstone, clay ironstone, and stinkstone. The sandstone is white, principally composed of grains of transparent quartz, with a few scales of silver-white mica. Sometimes the ironstone is imbedded in the sandstone, and occasionally the sandstone is much impregnated with iron-pyrites, and in some masses was ironshot. The stinkstone was of the same description as that found in Prince Regent's

* In Prince Regent's Inlet, whales were found to be very abundant.

Inlet. Specimens of madrepores, slightly mineralized, were picked up, and these probably were derived from some neighbouring beds of limestone, or were connected with the stinkstone.

On the 4th of September they were in Long. 110° W.; and here they discovered an island, which appeared to be larger than any that had hitherto been seen, and which was named *Melville Island*, in honour of the First Lord of the Admiralty. This island extends from Long. 106° W. to 114° W. On the 8th of September, the ships reached 112° W., and were inclosed for several days in the ice. Winter was now fast approaching; the ice was rapidly increasing, and violent north-westerly gales kept it in a constant and dangerous state of agitation.

These circumstances, of course rendered the navigation very difficult, and began to endanger the safety of the ships. Our brave countrymen, however, continued to contend with these difficulties till the 22d of September, when it was evident to all that farther navigation was at an end for the season; and therefore prudence dictated their retreat to a secure haven for the arctic winter. For this purpose, they returned eastward, and found a harbour in Melville Island. But the ice had already formed nearly a foot thick, and therefore the crews were forced to cut a passage for three miles through it. The 28th September, in short, had arrived before they were fixed in their winter quarters, in five fathoms water, and within about 200 yards from the shore. The latitude of this harbour, named *Winter Harbour*, is 74° N. and Long. 111° W. Hitherto, they had never lost sight of a continuous barrier of ice to the southward; that is, from West Long. 90° to the extreme point of Melville Island *.

Every thing was soon made ready for the formidable winter of these regions. The decks were covered with a housing composed of boards and sail-cloth, and pipes were passed in various directions around the vessel for conveying heated air. The thermometer was below the zero of Fahrenheit's scale, when the expedition entered *Winter Harbour*. *The sun entirely disappeared on the* 11*th of November*. In the month of November, the spirit

* It would appear from the reports of the officers, that the expedition was within a short distance of one of the magnetic poles.

of wine thermometer was 50° below zero; and in February, the coldest month of these regions, the spirit of wine thermometer pointed to the 54° and 55° below zero; and we have been told that the mean temperature for twelve months, was found to be about $1\frac{1}{2}$° to 2° below zero. During these intense colds, the crews felt but little inconvenience, so long as they remained under the housing of the ships; but when the atmosphere was agitated by gales of wind, then the cold became tremendous, and every one was forced to seek shelter below. Scarcely any accident occurred from exposure to cold; while the constant and regular exercise, which formed a necessary part of the duty of the crews, kept every one lively, active, and free from disease. *One death only took place during the expedition*, and that was in the case of an individual who had contracted the disease of which he died before he left England.

When the sun had its greatest southern declination, a light was still perceptible at noon in the southern horizon, affording sufficient light to read a book with difficulty. The day was like the fine clear evening of winter in our climate. The stars shone with great brilliancy, and when the moon appeared in the firmament, she shone with uncommon splendour. The polar lights frequently made their appearance, and were generally of a yellowish-grey colour, sometimes green, but rarely red, and most commonly situated in the south-west. Their lustre was not particularly striking, no noise was heard to proceed from them, and the magnetic needle did not appear to be affected by their presence.

The sun reappeared on the 3d of February, after an absence of eighty-three days, and his first rays were hailed from the mast-head. In April, some partial symptoms of thaw appeared. By the end of May regular thaw commenced. Nearly about this time, Captain Parry, with a party of his officers and men, crossed Melville Island, and reached the sea on the opposite side, in Liddon's Gulph, in Latitude 75° N. Here they discovered several other islands, one of which was named Sabine Island, in honour of Captain Sabine, one of the officers of the Expedition: They were fourteen days absent, during which time many interesting observations were made, and numerous specimens, illustrative of the natural history of the island, were collected. It is reported, that the skeleton of an immense whale was found some miles from the sea-shore. The rocks in the island appear to be partly primitive, partly secondary, and in various places there were considerable alluvial formations. The primitive rocks were red granite, sometimes passing into gneiss: gneiss, some varieties of which contained red garnets and minute crystals, apparently of hyacinth: milk-quartz, with intermixed grains of red felspar; and hornblende rock, with coarse serpentine, were observed in different quarters. On the shores of Liddon's Gulph the red granite was found to abound with pistacite. Of the secondary rocks the most frequent was grey sandstone, which we were told was the most abundant rock in the island. It is principally composed of quartz, with fine scales of mica, and sometimes contains portions of brown-coal, and ironstone, and also vegetable impressions. In one specimen the impression was of a species of the fossil genus, Lepidodendron of Sternberg, Palmacites of Schlotheim *, and is one of those tropical looking trees of the palm tribe, frequently met with in our coal-fields. From this fact, and others already mentioned, it appears that the rocks of the new discovered lands contain, and not unfrequently, fossil remains of genera of animals and vegetables, that now no longer occur in a living state, but in the warmer parts of the temperate zones, or in the tropical regions. Along with the sandstone were found masses of brown-coal, containing mineral pitch; and we were informed that compact grey limestone, generally containing intermixed calcareous spar, was very abundant.

From the few specimens of the mineral productions of the newly discovered lands we have had an opportunity of seeing, and the accounts we received, it appears, that, in their nature and arrangement, they do not differ from those met with in the old world, thus shewing, that primitive and secondary rocks in all great tracts of country, have every where the same general characters and arrangement. The hills in Melville Island are not very high, and we understand that,

* Versuch einer Geognostisch-botanischer Darstellung der Flora der Vörwelt, von Grafen Kaspar Sternberg. Leipzig 1820.—Die Petrefactenkunde auf ihren jetzigen Standpunkte, von Baron von Schlotheim. Gotha, 1820.

from the entrance of Lancaster Sound to Melville Island, the land became gradually lower and less rugged, till, from lofty and peaked summits, it became gently undulated.

Vegetables of various descriptions were collected on Melville Island, and we observed in a small collection, specimens of twenty-two different genera, of which the following is a partial list.

1. Festuca? ?
2. Koeleria of Persoon.
3. Arundo capitatum, Smith.
   Scheuchzeri of Persoon.
4. Rumex digynus.
5. Andromeda tetragona.
6. Silene.
7. Saxifraga petræa.
   bulbifera, Fl. Dan. T. 390.
8. Cerastium.
9. Potentilla.
10. Dryas integrifolia of Persoon.
11. Papaver nudicaule.
12. Ranunculus nivalis.
13. Pedicularis hirsuta.
14. Draba alpina?
    alpina certainly.
    stellata, Fl. Dan. t. 142.
    the nivalis of Wildenow.
15. Cochlearia.
16. Iberis? ?
    Iberis?
17. Astragalus.
18. Salix, several species.
19. Silene.
20. Rhodiola rosea.
21. Fontinalis squamosa.
22. Lichen nivalis.
    Lichen?

Vegetation was marvellously rapid, and some seeds brought from England, planted in Melville Island, were soon above ground. Shells of different kinds, various crustaceous animals, and many of the smaller corals and coralines were collected on the shores of this island. Few fishes were seen during the expedition, but considerable variety of the feathered tribe, and, amongst others, the owl, ptarmigan, arctic gull, glaucous gull, and that beautiful species, the king-duck, were killed in Melville Island. In the same quarter, we are informed, that the bear, arctic fox, hare, musk-ox, wolf and rein-deer, were not uncommon, and that a species of mouse was observed to change its fur from a brown to a pure white colour. No natives were met with in any of the newly discovered lands, but in Melville Island remains of huts were noticed by Mr Fisher, the assistant surgeon of the Hecla, and some others of the party who accompanied Captain Parry across the island.

On the return of the party, the ice in *Winter Harbour* was rapidly dissolving, and by the end of July it had entirely disappeared. Yet the ships were still blocked up by the exterior ice. It was not until the 30th that the outside ice began to crack; on the 31st of July, it moved off very gently, and released the crew from their winter prison, where they had been shut up for 310 days. Capt. Parry, in his official communication to John Wilson Croker, Esq. Secretary of the Admiralty, says, "He proceeded to the westward immediately on the breaking up of the ice at the commencement of the present season, the ships being in perfect condition, the officers and men in excellent health, and with every prospect of the final accomplishment of our enterprise. At the south-west end of Melville Island, however, the quantity and magnitude of the ice was found to increase so much, that for sixteen days (being above one-third of the whole navigable season in that part of the polar sea,) it was found impossible to penetrate to the westward beyond the meridian of 113° 47′ west. In order, therefore, that no time might be lost, I determined to try what could be done in a more southern latitude, and for that purpose ran back along the edge of the ice, which had hitherto formed a continuous barrier to the south of us, in order to look out for any opening which might favour the plan I had in view: in this endeavour I was also disappointed, and the season being so far advanced as to make it a matter of question whether, with the remaining resources, the object of the enterprise could now be persevered in with any hope of success, I consulted the principal officers of the expedition, who were unanimously of opinion that nothing more could be done, and that it was on that account advisable to return to England. In this opinion, it was impossible for me, under existing circumstances, not to concur, and I trust that the detailed account of our proceedings, which I shall shortly have the honour to lay before their Lordships, will prove highly satisfactory, and that though our exertions have not been crowned with complete success, they will not be found discreditable to the naval honour of our country *."

* Throughout the year, as we are informed, the wind blows almost constantly either from the north, or from northern points of the compass, in the sea discovered by Parry. As soon as the heat of the sun becomes powerful, the ice is released from the northern coasts, and driven towards the south. Thus, instead of the southern sides of bays, straits, and seas, affording open sea, it actually happens, that the openings exist on the northern sides, where prevailing north winds detach the frozen mass from the shore, and blowing it off, leave a passage between

For the urgent and satisfactory reasons just stated, the further progress of the expedition was put an end to for the present, and although land was seen to the south-west in Longitude 118°, no accurate opinion could be formed as to its nature or extent. It is, we observe, named in the copy of the Admiralty Chart, engraved for this number of the Journal, *Banks Land,* in honour, we presume, of the late illustrious President of the Royal Society.

The expedition now returned eastward through the Polar Sea and Barrow's Straits, into Sir James Lancaster's Sound, thence into Baffin's Bay, and, by the usual track homewards, arrived in safety, and the crew in perfect health, in England, during the course of the month of November.

Science will, we have no doubt, profit much by this expedition, and although it was locked up for the greater part of the time in ice, and enveloped in darkness, yet great activity and skill in a totally new field could not be employed but in a manner most advantageous to the high interests of philosophy. We have heard many interesting reports of the meteorological and magnetical observations, and the geographer must already see that the way to the Polar Sea has been discovered,—that Prince Regent's Inlet is very probably one of the passages to Hudson's Bay from the Polar Sea,—that the west side of Baffin's Bay and Davis' Straits are bounded, not by the mainland of America, but more likely by a chain of islands,—that West Greenland itself is not a portion of the Continent of America, but a great island,—that the north coast of the Continent of America extends from Icy Cape by the sea of Hearne, down to Repulse Bay, or some other inlet, into Hudson's Bay; and that to the north of this line of coast lie the islands discovered by the expedition, and probably many others, whose examination is reserved for future navigators, who may follow the track of Parry and his intrepid companions.

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the ice and the land. On their return up Barrow's Strait and Lancaster's Sound, the expedition reaped the benefit of this discovery, sailing on the north side, while the south side was blocked up. From Hearne and Mackenzie having reported an open sea on the north coast of America, we would be inclined to suppose, that the heat of the American land loosens the ice, and that, by the prevalence of southerly winds, it is blown off the land, and driven northward, where it is dispersed by currents.

Art. XXIV.—*On the existence of two Burning Volcanoes in Central Tartary* *.

M. Louis Cordier, an eminent French mineralogist, having applied to M. Abel Remusat, well known by his acquirements in Oriental literature, for some information respecting the sal-ammoniac, in which the Kalmucks carry on a great trade in different parts of Asia, the latter was led to consult the Japanese edition of the Chinese Encyclopædia. In this work, which contains details respecting the productions, the arts and the geography of Eastern Asia, he found the following curious passage: "The salt called by the Chinese *Nao-cha*, and also *salt of Tartary*, and *volatile salt*, is obtained from two mountains of Central Tartary. The one is the volcano of Tourfan †, which has given to that town, (or rather to a town situated two leagues from Tourfan,) the name of *Ho-Tcheou*, or the *Town of Fire*. The other is the White Mountain, in the country of Bisch-Balikh ‡. These two mountains eject continually flames and smoke. There are cavities in them, where they collect a green fluid, which, when evaporated, is changed into a salt, which is *Nao-cha*. It is collected by the people of the country, who use it in the preparation of leather.

"With respect to the mountain of Tourfan, a column of smoke is seen constantly issuing from it, and the smoke is replaced in the evening by a flame similar to that of a torch. The birds and other animals which are illuminated by it appear of a red colour. This mountain is called the *Mountain of Fire*. In order to seek the Nao-cha, the people put on sabots, as soles of leather would be speedily burned.

"The people of the country collect all the mother waters, which they boil, and from which they extract sal-ammoniac, in the form of cakes, similar to those of common salt. The whitest,

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* Abridged and Translated from the *Annales des Mines*, tom. v. p. 135.

† Situated in East Long. 89° 31′ and North Lat. 43° 30′ according to P. Gaubil.

‡ A Town situated on the River Ili, to the S.W. of the Lake of Balgasch, which the Chinese also call the Warm Sea. According to P. Gaubil, the latitude of the Lake of Balgasch is 46° and its Long. 78° 31′ East.

Nao-cha, is reckoned the best. This salt is of a very penetrating nature. It is kept suspended in a stove above the fire, in order to dry it, and ginger is then added, for the purpose of preserving it. When exposed to the cold, or to humidity, it deliquesces and is lost."

M. Remusat has remarked, that there are still several other places where the Chinese place volcanoes, of which Europeans have no precise knowledge.

The existence of two volcanoes, at the distance of 400 leagues from the Caspian Sea, which is the nearest to them, is considered by M. Cordier as a fact very interesting in a geological point of view. He regards the fact as unquestionable, and supports this opinion by shewing, that sal-ammoniac is almost always * a product of art, unless when it is obtained from volcanoes; and is not a native salt in any country. He mentions, that, according to Ferrara, the lava ejected from Ætna in 1635 furnished considerable quantities; and that, according to Boccone and Borelli, the eruption of 1669 furnished prodigious quantities of this salt, which were embarked for different parts of Italy. In modern times, M. Ferrara found it abundantly in the lava of 1763. In 1780, more than 1000 pounds were collected. The lava of 1792 yielded a little; and that of 1811 gave as much as to supply all the manufactories and apothecaries' shops in Sicily. Sal-ammoniac is also exhaled unceasingly from the Solfatara of Pozzuola, and one of the great apertures of it has been wrought for several years, for the purpose of extracting the sal-ammoniac †.

M. Cordier terminates his observations by remarking, "that the discovery of M. Abel Remusat gives a finishing blow to that hypothesis, which had for its object to explain all the volcanic phenomena by the filtration of the waters of the ocean into subterraneous cavities containing burning materials, which serve as fuel for volcanic eruptions."

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* That which comes from Egypt is obtained from the soot which covers the subterranean huts of the inhabitants.

† See Breislak's *Voyages Phys. et Lithologique dans la Campanie*, vol. ii. p. 69.

Art. XXV.—*On Sounds inaudible by certain Ears**. By William Hyde Wollaston, M. D. F. R. S.

It is not my intention to occupy the time of this Society, with the consideration of that mere general dullness to the impression of all kinds of sound which constitutes ordinary deafness, but to request its attention to certain peculiarities that I have observed with respect to partial insensibility in different states of the ear, and in different individuals; for I have found that an ear, which would be considered as perfect with regard to the generality of sounds, may, at the same time, be completely insensible to such as are at one or the other extremity of the scale of musical notes, the hearing or not hearing of which seems to depend wholly on the pitch or frequency of vibration constituting the note, and not upon the intensity or loudness of the noise.

Indeed, although persons labouring under common deafness have an imperfect perception of all sounds, the degree of indistinctness of different sounds is commonly not the same; for it will be found upon examination, that they usually hear sharp sounds much better than low ones; they distinguish the voices of women and children better than the deeper tones in which men commonly speak; and it may be remarked, that the generality of persons accustomed to speak to those who are deaf, seem practically aware of this difference, and, even without reflecting upon the motives which guide them, acquire a habit of speaking to deaf persons in a shriller tone of voice, as a method by which they succeed in making them hear more effectually than by merely speaking louder.

In elucidation of this state of hearing, which casually occurs as a malady, I have observed, that other ears may for a time be reduced to the same condition of insensibility to low sounds. I was originally led to this observation, in endeavouring to investigate the cause of deafness in a friend, by trial of different modes of closing, or otherwise lessening the sensibility of my own

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* From the *Philosophical Transactions* for 1820, part ii. p. 306.—314. As this valuable paper is incapable of abridgment, we have presented it to our readers in its entire state.

ears. I remarked, that when the mouth and nose are shut, the tympanum may be so exhausted by a forcible attempt to take breath by expansion of the chest, that the pressure of the external air is strongly felt upon the membrana tympani, and that, in this state of tension from external pressure, the ear becomes insensible to grave tones, without losing in any degree the perception of sharper sounds.

The state to which the ear is thus reduced by exhaustion, may even be preserved for a certain time, without the continued effort of inspiration, and without even stopping the breath, since, by sudden cessation of the effort, the internal passage to the ear becomes closed by the flexibility of the Eustachian tube, which acts as a valve, and prevents the return of air into the tympanum. As the defect thus occasioned is voluntary, so also is the remedy; for the unpleasant sensation of pressure on the drum, and the partial deafness which accompanies it, may at any instant be removed by the act of swallowing, which opens the tube, and by allowing the air to enter, restores the equilibrium of pressure necessary to the due performance of the functions of the ear.

In my endeavours to ascertain the extent to which this kind of deafness may be carried, some doubt has arisen, from the difficulty of finding sounds sufficiently pure for the purpose. The sounds of stringed instruments are in this respect defective; for unless the notes produced are free from any intermixture of their sharper chords, some degree of deception is very liable to occur in the estimate of the lowest note really heard. I can, nevertheless, with considerable confidence, say, that my own ears may be rendered insensible to all sounds below F marked by the base cliff. But as I have been in the habit of making the experiment frequently, it is probable that other persons who may be inclined to repeat it, will not with equal facility effect so high a degree of exhaustion as I have done. To a moderate extent the experiment is not difficult, and well worth making. The effect is singularly striking, and may aptly be compared to the mechanical separation of larger and smaller bodies by a sieve. If I strike the table before me with the end of my finger, the whole board sounds with a deep dull note. If I strike it with my nail, there is also at the same time a sharp sound produced by quicker vibrations of parts around the point of contact. When the ear is exhausted it hears only the latter sound, without perceiving in any degree the deeper note of the whole table. In the same manner, in listening to the sound of a carriage, the deeper rumbling noise of the body is no longer heard by an exhausted ear; but the rattle of a chain or loose screw remains at least as audible as before exhaustion.

Although I cannot propose such an experiment as a means of improving the effect of good music, yet, as a source of amusement even from a defective performance, I have occasionally tried it at a concert with singular effect; since none of the sharper sounds are lost, but by the suppression of a great mass of louder sounds, the shriller ones are so much the more distinctly perceived, even to the rattling of the keys of a bad instrument, or scraping of catgut unskilfully touched.

Those who attempt exhaustion of the ear for the first time, rarely have any difficulty in making themselves sensible of external pressure on the tympanum; but it is not easy at first to relax the effort of inspiration with sufficient suddenness to close the Eustachian tube, and thus maintain the exhaustion; neither is it very easy to refrain long together from swallowing the saliva, which instantly puts an end to the experiment.

I may here remark, that this state of excessive tension of the tympanum is sometimes produced by sudden increase of external pressure, as well as by decrease of that within, as is often felt in the diving-bell as soon as it touches the water; the pressure of which upon the included air closes the Eustachian tube, and, in proportion to the descent, occasions a degree of tension on the tympanum, that becomes distressing to persons who have not learned to obviate this inconvenience. Those who are accustomed to descend, probably acquire the art of opening the Eustachian tube by swallowing, or incipient yawning, as soon as the diving-bell touches the water.

It seems highly probable, that in the state of artificial tension thus produced, a corresponding deafness to low tones is occasioned; but, as I never have been in that situation, I have not had an opportunity of ascertaining this point by direct experiment.

In the natural healthy state of the human ear, there does not seem to be any strict limit to our power of discerning low sounds. In listening to those pulsatory vibrations of the air of which sound consists, if they become less and less frequent, we may doubt at what point tones suited to produce any musical effect terminate; yet all persons but those whose organs are palpably defective, continue sensible of vibratory motion, until it becomes a mere tremor, which may be felt and even almost counted.

On the contrary, if we turn our attention to the opposite extremity of the scale of audible sounds, and, with a series of pipes exceeding each other in sharpness, if we examine the effects of them successively upon the ears of any considerable number of persons, we shall find (even within the range of those tones which are produced for their musical effects) a very distinct and striking difference between the powers of different individuals, whose organs of hearing are in other respects perfect, and shall have reason to infer, that human hearing in general is more confined than has been supposed with regard to its perception of very acute sounds, and has probably, in every instance, some definite limit, at no great distance beyond the sounds ordinarily heard.

It is now some years since I first had occasion to notice this species of partial deafness, which I at that time supposed to be peculiar to the individual in whom I observed it. While I was endeavouring to estimate the pitch of certain sharp sounds, I remarked in one of my friends a total insensibility to the sound of a small organ pipe, which, in respect to acuteness, was far within the limits of my own hearing, as well as of others of our acquaintance. By subsequent examination, we found that his sense of hearing terminated at a note four octaves above the middle E of the piano-forte. This note he seemed to hear rather imperfectly, but he could not hear the F next above it, although his hearing is in other respects as perfect, and his perception of musical pitch as correct as that of any ordinary ears.

The casual observation of this peculiarity in the organ of hearing, soon brought to my recollection a similar incapacity in a near relation of my own, whom I very well remember to have said, when I was a boy, that she never could hear the chirping that commonly occurs in hedges during a summer's evening, which I believe to be that of the gryllus campestris.

I have reason to think, that a sister of the person last alluded to had the same peculiarity of hearing, although neither of them were in any degree deaf to common sounds.

The next case which came to my knowledge was in some degree more remarkable, in as much as the deafness in all probability extended a note or two lower than in the first instance. This information is derived from two ladies of my acquaintance, who agree that their father could never hear the chirping of the common house-sparrow. This is the lowest limit to acute hearing that I have met with, and I believe it to be extremely rare. Deafness even to the chirping of the house-cricket, which is several notes higher, is not common. Inability to hear the piercing squeak of the bat seems not very rare, as I have met with several instances of persons not aware of such a sound. The chirping which I suppose to be that of the gryllus campestris, appears to be rather higher than that of the bat, and accordingly will approach the limit of a greater number of ears; for, as far as I am yet able to estimate, human hearing in general extends but a few notes above this pitch. I cannot, however, measure these sounds with precision; for it is difficult to make a pipe to sound such notes, and still more difficult to appreciate the degree of their acuteness.

The chirping of the sparrow will vary somewhat in its pitch, but seems to be about four octaves above E in the middle of the piano-forte.

The note of the bat may be stated at a full octave higher than the sparrow, and I believe that some insects may reach as far as one octave more; for there are sounds decidedly higher than that of a small pipe one-fourth of an inch in length, which cannot be far from six octaves above the middle E. But since this pipe is at the limit of my own hearing, I cannot judge how much the note to which I allude might exceed it in acuteness, as my knowledge of the existence of this sound is derived wholly from some young friends who were present, and heard a chirping, when I was not aware of any sound. I suppose it to have been the cry of some species of gryllus, and I imagine it to differ from the gryllus campestris, because I have often heard the cry of that insect perfectly.

From the numerous instances in which I have now witnessed the limit to acuteness of hearing, and from the distinct succession of steps that I might enumerate in the hearing of different friends, as the result of various trials that I have made among them, I am inclined to think, that at the limit of hearing, the interval of a single note between two sounds, may be sufficient to render the higher note inaudible, although the lower note is heard distinctly.

The suddenness of the transition from perfect hearing to total want of perception, occasions a degree of surprise, which renders an experiment on this subject with a series of small pipes among several persons rather amusing. It is curious to observe the change of feeling manifested by various individuals of a party in succession, as the sounds approach and pass the limits of their hearing. Those who enjoy a temporary triumph, are often compelled in their turn to acknowledge to how short a distance their little superiority extends.

Though it has not yet occurred to me to observe a limit to the hearing of sharp sound in any person under twenty years of age, I am persuaded, by the account that I have received from others, that the youngest ears are liable to the same kind of insensibility. I have conversed with more than one person who never heard the cricket or the bat, and it appears far more likely that such sounds were always beyond their powers of perception, than that they never had been uttered in their presence.

The range of human hearing comprised between the lowest notes of the organ and the highest known cry of insects, includes more than nine octaves, the whole of which are distinctly perceptible by most ears, although the vibrations of a note at the higher extreme are six or seven hundred fold more frequent than those which constitute the gravest audible sound.

Since there is nothing in the constitution of the atmosphere to prevent the existence of vibrations incomparably more frequent than any of which we are conscious, we may imagine that animals like the grylli, whose powers appear to commence nearly where ours terminate, may have the faculty of hearing still sharper sounds, which at present we do not know to exist; and that there may be other insects hearing nothing in common with us, but endued with a power of exciting, and a sense that perceives vibrations of the same nature indeed as those which constitute our ordinary sounds, but so remote, that the animals who perceive them may be said to possess another sense, agreeing with our own solely in the medium by which it is excited, and possibly wholly unaffected by those slower vibrations of which we are sensible.

Art. XXVI.—*Description of a New Double Image Micrometer for Measuring the Diameter of Minute Celestial Objects.* By David Brewster, LL. D., F. R. S. Lond. & Ed. &c.

EVERY double image micrometer in which the angle is varied by optical means, must consist of two separate parts, one of which produces the duplication of the image, while the other varies the magnifying power of the telescope, and thus separates the two images, or causes them to approach, till an accurate contact is obtained.

In the micrometer described by the Reverend Dr Pearson, (see this *Journal*, Vol. III. p. 189,–190.) the double image is produced by a prism of rock-crystal placed between the first eye-glass and the eye, and the variation of the angle is effected by separating the lenses of which it consists. We do not know what part of this instrument Dr Pearson claims as his own; but the variable eye-piece which he uses, was invented by me in 1805; and the prism of rock-crystal is the undoubted invention of that ingenious and amiable man the late Abbé Rochon, who used it both at the object-end of the telescope, in the middle of the telescope, and at the eye-end of the instrument.

The objections to the eye-piece micrometer described by Dr Pearson, may be ranked under three heads:

1. The imperfectly crystallised state of quartz, which is never perfectly homogeneous, and in which minute lines and veins of different refractive powers may be always seen by proper precautions.

2. The difficulty of obtaining the exact sections of the crystal that are required, from the want of natural fractures to guide the artist in his operations.

3. The imperfect achromatism of the eye-piece when the moveable lens or lenses are placed in different positions.

4. The inferiority of achromatic to reflecting telescopes, for examining minute luminous objects with high magnifying powers.

We believe it is now universally admitted, both among astronomers and opticians, that the correction of colour by the best achromatic telescopes, is too imperfect to allow them to be brought into comparison with the fine reflecting telescopes now made in England. For the ordinary purposes of astronomy, the achromatic telescope possesses peculiar advantages; but when it is directed to minute double stars, to luminous points, or to small planetary discs, its performance is inferior to that of the reflecting telescope. For these reasons, a Gregorian or Cassegrainian telescope is employed; and the variation of the magnifying power is produced in the manner which I have described in my Treatise on new Philosophical Instruments, namely, by separating the eye-piece from the great speculum, and procuring an adjustment by a motion of the small speculum *.

Having thus obtained what I conceive to be the most perfect of all methods of obtaining a variation of the angle,—a method, too, in which the performance of the telescope is in no respect injured, we may apply it to the various contrivances which have been invented for giving double images.

In adopting the principle of Rochon as one of the best, I form the doubly refracting prism out of the *colourless Topaz of New Holland*, which is much freer from veins and imperfections of crystallization than the purest rock-crystal, and has also the advantage of a lower dispersive power. In certain sections of the crystal, when we require only a very small separation of the

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* It may be proper to mention, that an oversight occurs in the investigation of the nature of the scale of this micrometer, which the mathematical reader will immediately discover.

images, we may preserve on two sides the natural surface of the cleavage, which I have often found to exceed the finest polish that can be given by art.

When the prism is constructed, it may be made to form part of the lens of the eye-piece next the eye, by cementing it to the outer surface of that lens; or it may be placed between that lens and the eye, as was done by Rochon and Dr Pearson, where it will give a double image of all objects seen through the telescope. The angular distance of these images being invariable for any given position of the eye-piece, they may be brought into contact by a motion of the eye-piece, to or from the great mirror, according as they were previously overlapped or separated.

Although we have proposed to follow Rochon in producing the double image by a doubly refracting crystal, yet there are other means of accomplishing this, which are well worth the attention of the practical astronomer.

1. The double image may be produced by a small bisected plane speculum, placed between the eye-lens and the eye, and one of the halves may be made to move by a screw, not for the purpose of bringing the images in contact, but in order to vary the constant angle, according as it is wanted for large or small discs.

2. The duplication of the image may be effected by bisecting the eye-lens, or by placing a bisected lens between the eye-lens and the eye. We have now before us a bisected achromatic lens, made by Tulley, which produces the two images with very unusual distinctness.

3. The two images may be formed by means of a slightly inclined face, ground upon a highly polished and parallel plate of Fluor-spar; one image being seen by half of the pupil, through the parallel plate, and the other through the inclined face. Fluor-spar is recommended, as producing the least dispersion under a given angle of deviation; but though the colour is perceptible even at small deviations, yet, we are persuaded, from experiment, that it will not occasion any sensible error in the results; and even this imperfection may be removed by the ordinary means.

Whatever method of doubling the image the practical astronomer may adopt, after a careful examination of all those that have hitherto been proposed, we beg to press upon his attention the contrivance which we have described for bringing the images in contact. It requires no additional lens or speculum, and gives equally distinct images at every part of the scale.

EDINBURGH, }
Nov. 20. 1820. }

ART. XXVII.—*Account of the Discoveries of M.* OERSTED, *respecting the Connection between Magnetism and Galvanism, and the subsequent Researches of Sir* HUMPHRY DAVY, *Bart. M.* AMPERE, *and M.* BIOT*.

THE connection between Electricity and Magnetism has long been a matter of probable conjecture, not merely from the influence of lightning and artificial electrical discharges on the magnetic needle, but also from the local coincidence between the beams of that decidedly electrical phenomenon, the Aurora Borealis, and the principal magnetic axis of the earth. No decisive experiments, however, were made to establish their identity; and if we except a very curious result, obtained by a member of the Royal Society of Edinburgh, of which we cannot at present obtain the particulars, the sole merit of having effected this discovery is owing to M. Oersted, Secretary to the Royal Society of Copenhagen.

Some years ago an attempt was made by several philosophers, to influence the magnetic needle, by placing it in the open galvanic circuit, but no effect was perceptible; and it occurred to Mr Oersted to make the experiment when the galvanic circle was complete. He immediately found that the magnetic needle

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* This paper has been drawn up from three articles in the *Journal de Physique*, tom. xci. p. 72. and other materials, kindly communicated to us by M. Blainville, before they appeared in his own excellent Journal. Sir Humphry Davy's paper has been read at the Royal Society; and we are fortunate in having obtained a correct account of its leading results.—D. B.

was moved from its position; but as his apparatus was feeble, and the results not strongly marked, he associated himself with his friend M. Esmark, Counsellor to the King, and provided a galvanic apparatus, consisting of twenty copper troughs, each of which was 12 inches square, with a breadth of about $2\frac{1}{2}$ inches. Each trough was furnished with two plates of copper, disposed so as to support the rod of copper which sustains the zinc plate in the fluid of the next trough. The conducting fluid consisted of pure water, containing $\frac{1}{60}$th of its weight of sulphuric acid, and as much nitric acid. The portion of each zinc plate immersed in the fluid is a square whose side is about ten inches long. A less powerful battery will be sufficient, provided that it is able to make a metallic wire red-hot. The opposite extremities of the pile are joined by a metallic wire, called the *Uniting Wire* (*fil conjonctif*, by Ampere and Biot,) and the name of the *Electric Conflict* was given to the effect which took place in the uniting wire, and in the space around it.

1. Above a magnetic needle, well suspended, and in equilibrio in the magnetic meridian, is placed a straight part of the uniting wire, so as to be horizontal and parallel to the needle, which may be done by bending it near its efficacious part. When this is done, the needle will be found to deviate from its position;—*the pole which is nearest the negative end of the battery will move to the westward,* and if the distance of the needle from the uniting wire does not exceed three-fourths of an inch, the declination of the needle will be 45°. At greater distances the declination decreases proportionally; and the distance remaining the same, the declination varies with the strength of the battery.

If the uniting wire is placed *below*, instead of above, the needle, the effects will be inverted, and *the pole which is nearest the negative end of the battery will move to the Eastward.*

2. Hence it follows, in general, that *if* NEGATIVE *electricity enters* ABOVE *the pole of the needle, it will decline to the* WEST, *and if it enters* BELOW, *it will decline to the* EAST.

If the uniting wire is made to turn in a horizontal plane, so as to deviate gradually from the magnetic meridian on either side, the declination of the needle will increase, if the wire approaches the needle, and will diminish if it recedes from it.

3. If, when the magnetic needle is rendered horizontal by a counterpoise, we place the uniting wire in the same horizontal plane, and parallel with it, no declination takes place, but *the needle dips, so that the pole where the* NEGATIVE *electricity enters, is* DEPRESSED, *when the wire is situated on the* WEST *side, and* RAISED *when it is situated on the* EAST *side.*

4. If the uniting wire is placed at right angles to the magnetic meridian, the needle remains at rest, whether it is placed above or below the uniting wire; excepting in the case when it is very near the pole of the needle, and then the pole will be raised, if the negative electricity enters from the west, and depressed when it enters from the east.

5. When the uniting wire is placed vertically, and receives the negative electricity at its upper end, then, *if it is opposite the pole of the needle, it will turn to the* EAST, *but if it is opposite a point between the pole and the centre of the needle, it will turn to the* WEST. When the negative electricity enters at the lower end, the phenomena are reversed.

6. If the uniting wire is bent into the form of Z, so as to form two parallel legs, it attracts or repels the poles of the needle according to certain circumstances of position. If we place the wire opposite one of the poles of the needle, the plane of the legs being perpendicular to the magnetic meridian, the negative electricity entering by the east leg, and the positive by the west leg, the pole will be *repelled* to the east or to the west, according to the situation of the plane of the legs. But if the negative electricity enters by the west leg, and the positive by the east leg, the pole will be *attracted.* If the plane of the legs is perpendicular to the magnetic meridian, and opposite a point situated between the extremity and the centre of the needle, all these effects will be inverted.

The nature of the uniting wire has no influence on the above phenomena. Wires of platina, gold, silver, brass, iron, plates of lead and tin, and even mercury, may be employed with the same success. Several wires twisted together, or metallic ribbons, may also be used. The uniting wire does not lose its effect when interrupted by water, unless when the interruption amounts to several inches in length.

The action of the uniting wire upon the needle may be transmitted without any diminution of its effect, through *glass, metals, wood, water, rosin, earthen-ware* and *stones.* Even when these various substances are interposed at the same time, they scarcely seem to diminish the effect. A disc of the electrophorus, plates of porphyry, a stone-ware vessel full of water, were interposed with as little effect, and the influence of the uniting wire continued the same when the needle was shut up in a brass box filled with water. As the ordinary galvanic and electrical influence has never been transmitted through these substances, the effects which take place in the conflict of electricity are totally different from those which belong to electrical attractions and repulsions.

Needles of brass, glass and gum lac were substituted in place of the magnetic needle; but they were not influenced by the action of the uniting wire.

In extending his electro-magnetic researches, M. Oersted has obtained several additional results of a very interesting nature.

He found that the electro-magnetic effects do not depend upon the intensity of the electricity, but solely on its quantity. A plate of zinc of six inches square, immersed into a vessel of copper containing the dilute acid, produces a considerable electro-magnetic effect; but when the plate has 100 square inches of surface, *it acts upon the needle with such force, that the effect upon it is sensible at the distance of three feet.* The effect is *diminished,* rather than increased, *when forty troughs, similar to this single one, are united in one battery* *.

In comparing the effect of a single galvanic arc with that of an apparatus composed of several, M. Oersted supposes Fig. 6. of Plate III. to represent a galvanic arc composed of one piece of zinc *z*, a piece of copper *c*, a metallic wire *a b*, and a fluid conductor *l*. The zinc always communicates a portion of its posi-

* M. Oersted found, that the discharge of a strong electric battery, transmitted through a metallic wire, produced no deviation in the needle; neither did a series of uninterrupted sparks produce any other effect than the ordinary attractions and repulsions. A galvanic pile of 100 discs of two inches square each, and of paper moistened with salt-water, is also destitute of any sensible effect.

tive electricity to the water, as the copper does of its negative electricity, which would produce an accumulation of negative electricity in the upper part of the zinc, and of positive electricity in the upper part of the copper, and the communication by *ab* did not re-establish the equilibrium by presenting a free passage to the negative electricity from *z* to *c*, and of the positive electricity from *c* to *z*. The wire *a b*, therefore, receives the negative electricity of the zinc, and the positive electricity of the copper; whereas a wire which forms a communication between the two poles of a battery, receives positive electricity from the pole of the zinc, and negative from that of the copper.

"If we attend to this distinction," says M. Oersted, "we may, with a single galvanic arc, arranged as I have described, repeat all the experiments which I had before made with a compound galvanic apparatus. One great advantage of this plan is, that we may form the arc sufficiently light to be suspended by a small metallic wire, so as to revolve round the axis of the wire prolonged; and in this way we may examine the action of a magnet on the galvanic arc.

"For this purpose I employed the arrangement in Fig. 7. which is a perpendicular section of it in the direction of its breadth, *cccc* being a trough of copper 3 inches high, 4 inches long, and ½ inch wide *. *z z*, a plate of zinc, kept in its place by two pieces of cork *l l*; *cffffz*, a brass wire about a quarter of a line in diameter; *a b*, a brass wire as small as possible, but capable of sustaining the apparatus; and *c a c*, a linen thread for attaching the wire to the apparatus. The trough contains the usual conducting fluid. The uniting wire of this apparatus will attract the north pole of the needle when it is placed on the left side of the plane *cffffz*, regarded in the direction *f z*. On the same side, the south pole will be repelled. On the other side of this plane, the north will be repelled and the south pole attracted. In effecting this, we must not place the needle above *ff*, nor below *f z* or *f c*. If, instead of presenting a small moveable needle to the uniting wire, we present to one of the extremities *ff*, *one of the poles of a strong magnet, the attraction or*

* These dimensions may vary to infinity, only the breadth should not be great, and the trough made of as thin plates as possible.

repulsion (indicated by the needle) *will cause the galvanic apparatus to revolve round the prolonged axis of the wire a b.*

If we substitute, in place of the conducting wire, a large ribbon of copper of the same breadth as the plate of zinc, a feebler effect only is produced. The effect is on the other hand increased by making the conductor very short.

Fig. 8. represents the perpendicular section of this arrangement, in the direction of the breadth of the trough; and Fig. 9. is a perspective view of it, in which *a b c d e f* represents the conducting plate, and *c z z f* the plate of zinc. Here the north pole of the needle will be attracted towards the plane of *a b c*, and the south pole will be repelled from the same plane; *c d f* will have contrary effects. In this apparatus the extremities act like the poles of the needle, but it is only the faces of the extremities, and not the intermediate parts that have this analogy.

A moveable galvanic apparatus may also be made of two plates, one of copper and one of zinc, twisted into spirals, and suspended in the conducting fluid. This apparatus is more moveable, but greater precautions are necessary to avoid deception when experiments are made with it.

I have not yet discovered a method of making a galvanic apparatus direct itself towards the poles of the earth. For such a purpose the apparatus would require to be much more moveable.

Account of Sir Humphry Davy's Experiments.

In repeating the interesting experiments of M. Oersted, Sir Humphry Davy found, that the *uniting wire* of platinum was magnetic from its power of attracting iron filings. This wire was also found to communicate permanent magnetism to steel bars transversely attached to it, or placed transversely at some distance from it; while the same bars, when placed parallel to the wire, had only a temporary magnetism when in the vicinity of the apparatus.

The most important fact, however, in Sir Humphry Davy's experiments, is, that when the electricity from a Leyden battery is passed through a wire or through air, *the wire and air and the* *surrounding space became magnetic, so that bars of steel made tangents or sines of circles round the wire all became magnets*, the north pole of one being opposite to the south pole of the other. By means of a powerful Leyden battery, Sir Humphry has made magnets at the distance of *fourteen inches* from the wire. He has also been able to attract and repell bars placed in the voltaic circuit by the common magnet. We wait with much impatience for the publication of this interesting paper, which was read at the Royal Society on the 16th November.

Account of Ampere's Experiments.

This eminent mathematician has communicated to the Academy of Sciences three memoirs, on the 18th and 25th September, and the 30th October 1820. The second of these memoirs is entitled "*Sur l'action mutuelle de deux Courans electriques, sur celle qui existe entre un courant electrique et un aimant, et celle de deux aimans l'un sur l'autre.*" The following are the principal conclusions deduced from this memoir.

1. "Two electric currents attract one another when they move parallel and in the same direction, and they repell one another when they move parallel and in opposite directions.

2. It follows, therefore, that when the metallic wires through which these currents are transmitted, can only turn in parallel planes, each of the two currents tends to bring the other into a situation where it may be parallel to it, and in the same direction.

3. These attractions and repulsions are absolutely different from the attractions and repulsions of ordinary electricity.

4. All the phenomena discovered by Mr Oersted, and which I analyzed, and reduced to two general facts in my first memoir, are embraced by the law of the two electrical currents, (§ 1.), admitting that a magnet is only an assemblage of electrical currents, produced by the mutual action of the particles of steel, analogous to that of the elements of a Voltaic pile, and which move in planes perpendicular to the line which joins the two poles of the magnet.

5. When the magnet is in the situation which it tends to take by the action of the terrestrial magnet, these currents have a direction opposite to that of the apparent motion of the sun,

and hence when we place a magnet in a contrary position, so that the poles which point to the poles of the earth are of the same name, the currents will be found in the direction of the apparent motion of the sun.

6. This law embraces the phenomena of the ordinary action of magnets.

7. It embraces also the phenomena of terrestrial magnetism, by supposing electrical currents in planes perpendicular to the direction of the dipping-needle, and which move from east to west.

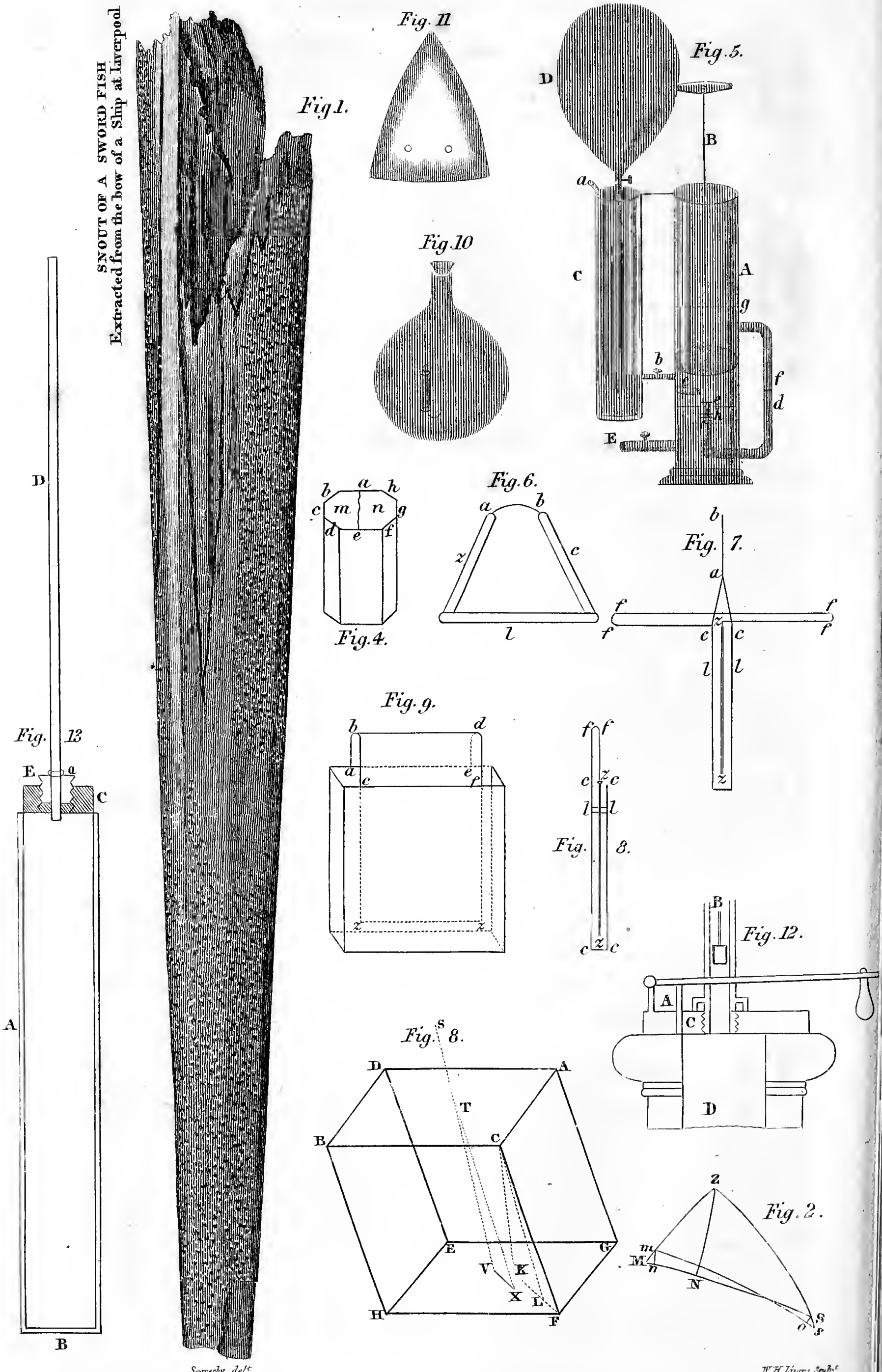
8. There is no other difference between the poles of a magnet than that one of them is found to the left, and the other to the right of the electric currents, which give to steel the magnetic property.

9. When Volta had proved that the positive and negative electricities of the pile attracted and repelled one another, according to the laws of ordinary electricity, he did not demonstrate completely the identity of the two fluids put in action by the pile and by friction; but it became a physical truth, perhaps, when he shewed that two bodies, one of which was electrified by metallic contact, and the other by friction acted upon one another in every case, as if they had been both electrified by the pile, or with the ordinary electrical machine,—the same kinds of proof are obtained with respect to the identity of the attractions and repulsions of electric currents and magnets. Magnetic attractions and repulsions, therefore, ought not to be assimilated to those which result from electrical tension, but to those which I have observed between two currents."

M. Ampere has communicated in his *third* Memoir, several very important results. *He has succeeded in directing the uniting wire* (fil conjonctif) *by the action of the earth.* Setting out from his method of considering the phenomena presented by the *uniting wires* of magnets, he concludes, that the moveable part of the uniting wire ought to form a curved plane, and almost shut, so that there remains only between its extremities an interval necessary to enable it to communicate with the pile, and that then the plane of this curve will be carried by the action of the terrestrial globe in a direction perpendicular to that of the dipping-needle. This conclusion has been fully confirmed by experiment.

According to the manner in which he suspends this part of

PLATE III.



Edinburgh Published by A. Constable & Co. 1820.

the uniting wire, he has obtained the motion in a horizontal direction, which corresponds with the declination of the compass, and a motion in the magnetic meridian corresponding to the dip.

Account of M. Biot's Experiments.

On the 30th October 1820, M. Biot presented a Memoir to the Academy, on the Physical Laws of the Electro-Magnetic Phenomena, which he had deduced from measures of the deviation and the oscillation experienced by needles placed near the uniting wire.

The following is the general expression which he has given of the action exerted at a distance upon a particle of austral or boreal magnetism, by a very fine uniting wire of copper, of an indefinite length, and put in communication with the two poles of a voltaic apparatus.

From the point where the particle resides, draw a perpendicular line to the axis of the wire. The force which acts upon the particle is perpendicular to this line and to the axis of the wire. Its intensity is in the inverse ratio of the simple distance. The nature of its action is the same as that of a magnetic-needle, which is placed tangentially to the contour of the wire, so that a particle of austral and a particle of boreal magnetism would be drawn in opposite directions, though always in the same straight line determined by the preceding construction.

ART. XXVIII.—*Account of the Piezometer, for Measuring the Compressibility of Water* *. BY JACOB PERKINS, Esq.

THE Piezometer employed by Mr Perkins in his experiments on the compressibility of water, is represented in Plate III. Fig. 13. The end B of a cylinder A, three inches wide and eighteen long, being made watertight by a plate firmly soldered to it a cap C, also water-tight, was made to screw on and off. The rod D, $\frac{5}{16}$ths of an inch in diameter, and carrying a flexible

* Abridged from the *Phil. Trans.* 1820, Part 2. p. 324.

ring *a*, was made to pass through a tight stuffing box E. A cannon D, Fig. 12. capable of containing the piezometer, was fixed vertically in the earth, the touch-hole being plugged tight, and the muzzle about 18 inches above ground. A strong cap A, was firmly screwed on at the mouth, and in the centre of it a small forcing pump B, with a piston $\frac{5}{8}$ths of an inch in diameter, was tightly screwed. A valve was introduced at the aperture C, to ascertain the degree of pressure, one pound of pressure on that valve indicating an atmosphere. The piezometer being introduced into the cannon, the water was forced in till the cap shewed signs of leakage, the valve at the same time indicating a pressure of 100 atmospheres. When the piezometer was taken out of the cannon, the flexible ring *a* was *eight inches up the rod D*, which proved that the rod had been forced that length into the cylinder, and that the compression was about 1 *per cent.* In order to produce this compression, 3 *per cent.* must be pumped into the gun, an effect arising from the expansion of the gun, or the entrance of the water into the pores of the cast-iron.

On his voyage to England, Mr Perkins repeated this experiment frequently, and with the same result, by sinking the piezometer with fifty-four pounds of lead, to the depth of 500 fathoms, which gives nearly a pressure of 100 atmospheres.

Being satisfied that the above piezometer would not shew all the compression, he made another, consisting of a small tube, closed at the lower end, and water-tight. At the upper end the water entered through a small aperture, closed by a sensible valve opening inwards. It was then perfectly filled with water, (the weight of which was accurately known) and subjected in a hydraulic press to a pressure of about 326 atmospheres. When taken out and weighed, there was found *an increase of water, amounting to $3\frac{1}{2}$ per cent.* This water had been previously boiled, and cooled down 48°, and kept at that temperature during the experiment, which was performed before many scientific individuals.

Mr Perkins made several curious experiments, by sinking strong empty porter bottles to different depths; but we must refer for an account of these to the Philosophical Transactions, as they do not contain any very precise results.

Art. XXIX.—*Account of Mr Oxley's Observations on the Variation of the Needle, &c. in New Holland.*

THE great value which is now attached to accurate measures of the variation of the needle, particularly when made in countries remote, and almost inaccessible to ordinary travellers, has induced us to collect all the magnetical observations which are scattered through Mr Oxley's *Journals of Two expeditions into the interior of New South Wales,* which has just been published. We have compared the observations in the text with those engraved on the chart, and have thus been enabled to correct some typographical errors in the measures, and to add the longitude and latitude where they had been omitted *.—D. B.

First Expedition in 1817.

South Latitude.	East Longitude.		Easterly Variation.
33° 40′ 0″	148° 21′ 0″	April 27.	7° 47′ 0″
33 15 34	147 16 0	May 16.	7 0 8
34 8 8	146 3 0	June 2.	7 18 0
34 11 0	145 56 0	June 4.	7 44 0
34 13 33	146 0 0	June 5.	8 0 8
33 24 0	145 46 0	June 22.	7 45 0
33 22 0	145 24 15	June 27.	7 30 0
33 22 22	145 5 50	July 1.	6 49 0 †
33 53 19	144 33 50	July 8.	7 25 0
		July 10.	7 47 0
33 14 0	146 7 0	July 23.	7 51 0
33 4 2	146 31 50	Aug. 1.	7 23 0
32 47 58	147 23 0	Aug. 8.	5 20 0 ‡
32 44 29	147 46 30	Aug. 11.	7 18 0
32 32 45	148 51 30	Aug. 20.	8 38 38
33 27 0	149 28 0	Bathurst,	8 40 0

* Captain Cook found the Variation at Botany Bay on the 6th May 1770, to be 8° east, and the Dip to be 67° 1′ south. Hansteen uses these measures in his charts of the variation and dip. In Churchill's Magnetic Chart, the variation is made about 3° or 4°.

† The Variation is 6° 11′ on the chart.

‡ There seems to be an error in this measure. As it occurs both in the chart and in the text, the smallness of the variation probably arises from local attraction, as afterwards happened at Loadstone Hill.

Second Expedition in 1818.

South Latitude.	East Longitude.	Easterly Variation.	
31° 49′ 005″	147° 52′ 15″	June 21.	8° 22′
31 18 0	147° 31 0	July 20.	7 48
31 14 14	148 18 0	Aug. 2.	8 14
31 13 30	148 38 0	Aug. 7.	6 22 *
31 13 0	148 41 30	Aug. 9.	7 ½
30 57 0	149 20 0	Aug. 23.	8 42
31 4 35	151 5 30	Sept. 6.	9 58
31 1 ½	151 26 ½	Sept. 8.	8 51 †
31 19 0	151 49 ½	Sept. 20.	10 39 ‡
31 23 10	152 8 0	Sept. 27.	8 22
31 24 0	152 51 ½	Port Macquarrie,	10 5
31 25 45	151 53 54	Ditto,	10 11 ‖
31 38 0	152 48 0	Oct. 13.	9 33

On ascending Mount Exmouth, Mr. Oxley was surprised with the remarkable effect which was produced upon the compass. On the highest part of the hill, near its centre, he placed the compass before him on the rock, and the card flew round with extreme velocity, and then suddenly settled at opposite points, the north point becoming the south. Astonished at this phenomenon, he made the following observations: "The compass on the rock Mount Exmouth bore S. 60° W. (its true bearing being N. 75° E.) and on raising it gradually to the eye, the card was violently agitated, and the same point now bore N. 67° E. About 100 yards farther south, the compass was again placed on the rock; the effect on the compass was very different, Mount Exmouth bore E. 48° S., and the tent in the valley beneath S. 74° W. The card, on raising the compass, was rather less agitated than before, and from the eye Mount Exmouth bore N. 77° E., and the tent S. 15° W., the

* This observation was made at Loadstone Hill, the effects of which will be presently described.

† The variation is 9° 51′ E. in the chart.

‡ The variation is 10° 40′ in the chart.

‖ The high water full and change is here 8^{h} 43′, and the rise of tide from four to five feet.

true bearing of the latter being S. 13½ W. Thus the magnetic fluid seemed on this spot to have less influence on the needle than on the spot where its power was first observed; and at a short distance from the base of the hill, the needle regained its natural position. The rocks, when broken, were of a dark iron-grey: they did not appear to contain any iron, for when tried at the tent, the magnet had no power over them. I could not discern any regular stratum of rock, the hill being covered with large detached stones, many of which form figures of five and six sides.

The variation of the needle was observed by azimuth to be 6° 22′."

Having again ascended Loadstone Hill, Mr Oxley repeated the above experiments with the same results. "Several different stations on the summit ridge were tried, and the needle was variously affected. The spot where the phenomenon was first observed, seemed to have the greatest effect on the needle. A common sewing-needle was strongly rubbed with a magnet, and balanced on the point of the rock, when it was much agitated, and the point flew round from the north to the south. The needle of the circumferentor, taken out of the box, was affected in a similar manner, only that when balanced on the rock, the fluid did not possess sufficient power to turn the point more than one point of the circle instead of quite round, as when balanced in the compass-box. A compound magnet was laid on the rock, and applied to it in different ways; but it did not seem in any manner affected by the power which had so surprised us with its effect on the compass." "The observations made here placed us in Lat. 31° 13′ S., Long. 148° 41′ 30″ E., and I estimate the mean variation to be about 7½° Easterly. We found that no reliance could be placed on bearings taken with the compass on heights in this vicinity, and I am fearful that the bearings taken from Mount Exmouth will require verification, a difference of 4° being observed in some, when compared with other bearings, which could not be supposed to be affected by the magnetic fluid."

Art. XXX.—*Reply to a Note in the Annales de Chimie by M. Arago, on the Phosphorescence of Fluor-Spar.*

In the *Annales de Chimie et de Physique* for July 1820, p. 297. the Editor has done us the honour to translate the paper *On the Phosphorescence of Minerals*, published in the 1st Volume of this Journal, and also the Notice in the 2d Volume, *On a Singular Developement of Crystalline Structure by Phosphorescence.* To the translation of this last notice, M. Arago has thought proper to add the following harsh observations, without taking the trouble of understanding the notice to which it is appended:

" *Note du Redacteur.*—Je laisse au lecteur à juger s'il n'est pas au moins extraordinaire, qu'après avoir remonté jusqu' a Benvenuto Cellini, pour tracer l'histoire des recherches que les physiciens ont faites sur la phosphorescence des mineraux, M. Brewster ne se soit pas ressouvenu d'une note de Pallas, qui a été inserée en 1783, dans le tome 1[er] des Mémoires de Petersbourg. Je vais reparer cet *oubli.*

" M. Pallas nous apprend que le spath-fluor de Catherinenbourg devient lumineux à la simple chaleur de la main, lorsqu'on l'y tient renfermé une demi-minute seulement. La lueur que le cristal repand alors est blanchâtre et pale ; à la chaleur de l'eau bouillante, cette lueur verdit ; par un temperature plus elevée, la lumiere phosphorescente passe d'un vert celadon au plus beau bleu de turquoise ; phenomenes que les fluors communs n'offrent pas.

" La couleur generale du filon est un violet pale ; on voit par-ci par-là des parties plus foncées ; ailleurs on remarque des couches d'une transparence blanchâtre tirant par fois sur le vert. Ce sont les veines verdâtres qui jouissent au plus haut degré de la vertu phosphoriques, et qui passent par la chaleur au bleu le plus vif. Dans le fluor qu'on trouve à la montagne d'Oubou-koun, près du Selenga, et dans ceux de Breintenbrunn en Saxe, qui sont veinés de vert sur un fond violet, *les veines vertes deviennent lumineuses par un chaleur mediocre, tandis que le reste* *n'emet aucune lueur sensible,* et quelquefois n'est point phosphorique de tout."

The preceding passage, which we have printed literatim as it stands in the original, evidently contains two charges, the one expressed, and the other implied. The expressed charge is, that I have very strangely omitted to quote Pallas's experiments on phosphorescence; and the implied one is, that Pallas's paper contains the same discovery which I have announced in my notice *On a Singular Developement of Crystalline Structure by Phosphorescence.*

The first charge is unworthy of notice; as an author is entitled to give, as he pleases, either a short or a copious history of the subject of which he treats. The experiments of many other philosophers are omitted, as well as those of Pallas; and the blame of omitting his name, must be shared with Mr Wedgwood, Haüy, and every other writer on the subject that I am acquainted with.

The other charge, which was intended to be a more serious one, is founded on an utter misconception of the result announced in my notice, arising, it is to be hoped, from an imperfect acquaintance with the English language.

The result obtained by Pallas may be thus expressed: "In the fluors of Ouboukoun, &c. which have green veins on a violet ground, the green veins are phosphorescent with a moderate heat, and the violet part is opaque." Now, it was known to all the world, that green fluor gave out a green light, and blue fluor sometimes a differently coloured light; and every child who has amused himself with heating some of the Derbyshire spars, which are generally blue and green, could not fail to notice, that the green gave out one light, and the blue a different light, or perhaps none at all. This fact I have observed repeatedly; and if I had published it as a new discovery, I might have been justly reminded, in the usual language of civility, by those who had a tender regard for Pallas's reputation, that he had anticipated me in this fact.

The result, however, contained in my paper, is very different from this. I take a piece of fluor-spar, which has perceptible veins in one part, and no appearance of them in another: I place it on a hot iron, and directing my attention to the *part without veins*, I find that *the phosphorescent matter is arranged in strata or veins*, (although no veins are seen), and upon looking to the *part with veins*, I observe, that the veins rendered visible by phosphorescence are parallel to the veins visible to the eye. In this experiment, I pay no attention to the phosphorescence of the veins visible to the eye; but I remark, that each stratum (not the strata visible to the eye, but the strata *rendered visible by phosphorescence)* emits a phosphoric light peculiar to itself. If any ground for misconception existed, it was entirely removed, by comparing the effect now described to that produced "*in a piece of chalky Tabasheer, of an uniform whiteness, where a veined structure is exhibited, after the partial discharge of the oil which it had unequally absorbed.*" Will the reader believe, that these three lines, though containing a curious fact, and highly illustrative of the subject under discussion, are not only omitted in M. Arago's translation of my paper, but are the *only lines* in it that are omitted*?

If the object of my notice had been to communicate the fact, that a veined structure gave a veined phosphorescence, it would have been entirely inconsistent with the title of it, which expressly states, that it is upon a *Singular* DEVELOPEMENT *of Crystalline Structure by Phosphorescence*; and when I found a veined structure thus luminously displayed, where the eye could not discern it, I had recourse to a microscope, and even then I found that the phosphorescence exhibited veins which could not be detected by the application of that instrument.

But let us suppose that my notice had nothing to do with the developement of crystalline structure, where it was not otherwise apparent, and let us suppose that it was only, like that of Pallas, a simple experiment on veined fluor-spar. Even in this point of view, it contains a new result. Pallas observed in a piece of violet spar, with green veins, that the *green veins were phospho-*

* That these lines were intentionally omitted, is very obvious; for in the paragraph which precedes the translation of my notice, the Editor says, "*En voici la substance.*" But instead of the substance, he has given the *whole notice*, excepting the *three lines* on tabasheer! The Editor had perhaps some good reason for keeping the word *Tabasheer* out of the Annales de Chimie.

rescent, and the blue part opaque, whereas I observed *three* different colours, besides the opaque portion, namely, *purple* light, *yellowish-green* light, and *whitish* light; and I venture to say, that the sight which I saw has never been described, and is one of the most splendid exhibitions of a natural phenomenon that can be witnessed. Had not my description of the experiment been printed the day after it was made, and when all the Plates of the Journal were thrown off, I should have given an engraving of it, which would have represented one of the finest patterns of the kaleidoscope, drawn with phosphoric light, and displaying the whole crystallographic structure of fluor-spar,—a structure, too, which could not be seen either by the naked eye, or by the aid of a microscope.

But beside the novelty and splendour of this phenomenon, we may claim for it a higher character, as it has led to the determination of the only general point which has been ascertained respecting the cause of phosphorescence, and which we shall be able to lay before our readers in a subsequent Number.

Here we intended to have concluded these remarks; but it naturally occured to us, that as M. Arago had given a garbled translation of my notice, by leaving out an important part, which tended to overturn his view of the matter, he might also have given a false quotation from Pallas. I therefore lost no time in procuring Pallas's Memoir, which was published in 1787, in the Petersburg Memoirs for 1783, and I found my suspicion completely verified *.

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* In order that the reader may judge for himself, I shall give in this Note the *whole* of Pallas's Memoir.

" Sa Majesté Impériale ayant remarqué Elle-même que des échantillons d'un spath fluor, récemment envoyés de Cathérinenbourg par M. le Gouverneur-Général *Kaschkin*, possedent non seulement un degré supérieur de la vertu phosphorique que l'on connoit à plusieurs espéces de fluors, au point de devenir lumineux dans l'eau chaude ; mais aussi que la lueur phosphorique qu'ils répandent à une chaleur plus forte passe d'un verd séladon au plus beau bleu de turquoise, phénomène que les fluors connus n'offrent pas : cette Grande Souveraine, toujours attentive à l'avancement des Sciences & gracieusement disposée envers Son Academie, m'a chargé de remettre à la Conférence un bel échantillon de ce fluor nouvellement découvert, avec plusieurs petits, qui peuvent servir aux expériences.

" Le grand échantillon, destiné pour le cabinet académique, montre clairement, que ce fluor s'est trouvé en filon, de la largeur d'une main, dans une gangue micacée dont les deux salbandes montrent des restes. La couleur de la plus grande

The reader cannot fail to have remarked, that M. Arago has, by means of *Italic printing*, contrasted Pallas's observation with mine; and he must have concluded, that the words in Italics, taken from Pallas's paper, are his own. It is however not so. Instead of "tandis que le reste *est encore opaque*," M. Arago substitutes, "tandis que le reste *n'emet aucune lueur sensible*," by which alteration, the incautious reader supposes, that Pallas observed in his veined specimen two different kinds of *lueur*, one *verte*, and the other *insensible*,—the last of which is a species of phosphoric light with which we are not acquainted.

In his zeal to do justice to the trivial merit of Pallas, in observing that green veins were luminous, and the violet mass opaque, the learned critic has not scrupled to do injustice to her Imperial Majesty the Empress of all the Russias, who actually discovered, as Pallas informs us, the only important fact in his paper, respecting *the change of colour by a change of temperature*, which M. Arago ascribes to Pallas. Now, we venture to say, that as the Empress Catharine made experiments on the phosphorescence of the veined fluor-spar of Catharinenburg, she could not

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épaisseur du filon, qui montre une cristallisation confusé transversale, est un violet pâle, en quelque endroits plus foncé; le milieu de la largeur du filon contient des portions d'un transparent blanchâtre, quelquefois verdâtre, dont une partie se détache en crystaux irréguliers & cuboïdes, dont les petits morceaux offrent quelques examples. Ces fragmens verdâtres contiennent la plus belle forte vertû phosphorique & passent à la chaleur au bleu le plus vif. J'ai remarqué, que ce petits fragmens developpent leur lueur phosphorique à la simple chaleur de la main, lorsqu'on les y tient renfermés pendant une demi-minute seulement. La lueur qu'ils répandent, n'est alors que blanchâtre & pâle, mais elle verdit à la chaleur de l'eau bouillante, & un degré de chaleur plus fort augmente l'intensité de cette couleur & étend l'atmosphère lumineuse de la pierre à plusieurs pouces.

"Le fluor phosphorique de Garpenberg, dont la lumiere est aussi un peu verdâtre, ainsi que le fluor verd trouvé dans les plus grandes profondeurs du Schlangenberg en Sibérie, n'ont jamais montré le même degré de couleur & de lumiere. Tous les autres fluors que j'ai essayé, sont infiniment moins lumineux et n'offrent qu'une lueur foible blanche ou pâle, au meme degré de chaleur. En faisant à cette occasion differens essays comparatifs avec plusieurs fluors de Saxe, d'Alsace, de Cornoualle, du Derbyshire & de Sibérie, j'ai remarqué qu'en général les fluors verds ou verdâtres phosphorisent plus promptement & avec plus de vigueur, que ceux qui sont violets. Dans le fluor qui se trouve à la montagne d'Ouboukoun, près du Selenga, & dans celui de Breitenbrunn en Saxe, qui est veiné du verd sur un fond violet, les veines vertes deviennent lumineuses par un chaleur médiocre, tandis que le reste est encore opaque; & quelquefois la partie violette ne phosphorise point du tout." *Nova Acta Acad. Scient. Imp. Petrop.* tom. i. pp. 157, 158.

fail to have anticipated Pallas in the observation, that the green veins were more phosphoric than the violet ones; and, out of respect to the character of that distinguished female, we shall, in our next history of phosphorescence, place her by the side of Benvenuto Cellini; and, in virtue of this resolution, we hereby replace the Phosphoric Gem in the diadem of her Imperial Majesty, and renounce for ever to her and the heirs of her royal reputation, all the honour of a discovery, which, in a selfish moment, we are said to have assumed to ourselves, to the deep distress of M. Arago, and all lovers of truth and candour.

D. B.

XXXI.—*Experiments on the Specific Gravity of Sea Water drawn in different Latitudes, and from various Depths in the Atlantic.* By Thomas Stewart Traill, M. D. F. R. S. E. &c. &c. In a Communication to Dr Brewster.

In the course of some experiments on the specific gravity of different fluids, I had occasion to examine sea-water drawn in different latitudes, and from various depths in the Atlantic Ocean. The result is somewhat remarkable; and though the number of my experiments may not entitle me to deduce from them a general law, yet their publication may excite the attention of those who have opportunities of repeating them. The specimens of sea-water were procured at my request by nautical friends some time ago; but all were taken up within the same year. Each specimen filled a common glass bottle, and had a label immediately affixed to it, indicating the place where it was obtained. The water, from considerable depths, for want of better apparatus, was procured by the following contrivance. It was found that a bottle might be so corked as to prevent the admission of water, until the pressure of the superincumbent column, on sinking it by an attached weight, pushed the cork inwards, when the escape of the air, and the filling of the bottle with water, again forced the cork into its neck, and thus obviated the change of displacement of the included water, as the bottle was drawn upward. The pressure required to force the cork being ascertained by previous experiment, the bottle, thus prepared, was sunk to the requisite depth; and after remaining there for half an hour or more, was drawn up and immediately secured.

My experiments were carefully conducted by means of a delicate balance, and a thin flask, capable of holding upwards of 1050 grains of distilled water, when its ground stopper was adjusted. A bottle of distilled water, and all the specimens of sea-water, were reduced to the same temperature, by being placed for many days on the same table, in a room without a fire; and to prevent error from this source, each liquid was examined by a good thermometer previously to the experiment. The weight of the distilled water bearing the same ratio to the weight of an equal volume of the other fluids, as 1.0000 to the sought specific gravities, is the simple formula from which the following table is deduced.

Table of Specific Gravities at Temperature 51° Fahr.

1.	Sea-water drawn from the surface, Lat. 47° 47′ N. Long. 10° 40′ W. - -	= 1.0277
2.	Ditto from the depth of 40 fathoms, ditto, ditto,	= 1.0280
3.	Ditto from the surface, Lat. 37° N., Long. 9° W. off Cape St Vincent, - -	= 1.0281
4.	Ditto from the surface, Madeira, bearing NE. distance 16 leagues, - -	= 1.0284
5.	Ditto from the depth of 40 fathoms in the same spot, - - -	= 1.0286
6.	Ditto from the depth of 36 fathoms, Lat. 26° N. Long. 64° W., during a voyage to Demerara,	= 1.0287
7.	Ditto from the surface, Lat. 22° 11′ N., Longitude not given; but as it was in the same voyage as No. 6. it was probably more to the west, - - -	= 1.0289
8.	Ditto from the surface, Lat. 8° 20′ N., Longitude not given; but as the three last numbers were obtained in the same voyage to Demerara, and this one, at my request, was taken when the Captain supposed that he would make land in a day or two, there can	

be little doubt of the ship being at this time just off the mouth of the Orinooko, = 1.0267

In calculating these specific gravities, I had carried them to several decimal places farther; but I have suppressed these in the Table, because it might appear an affectation of accuracy which the case does not admit; for the difference of a single $\frac{1}{10}$th of a grain in weighing each fluid in the above experiments, would make a difference of nearly $\frac{1}{10000}$th in their specific gravities; or would alter the last figure of the present decimal series.

The inferences to which these experiments lead, are,

1st, That the specific gravity of the waters of the Atlantic increases as we approach the Equator.

2d, That the specific gravity of sea-water increases with the depth from which it is drawn.

The only exception in the table to the first inference is No. 8.; but the great diminution of density here observed, is undoubtedly owing to the vast mass of rushing water poured into the ocean by the Orinooko, the stream of which is said to discolour the sea many leagues from land, and at a considerable distance from the shore to preserve the freshness of its current.

The results of Captain Scoresby's experiments on the specific gravity of sea-water, seem to agree with the inferences above mentioned. This intelligent navigator found, that the density of the waters of the ocean, near the meridian of Greenwich, gradually diminished from Lat. 57° 42′ N. to Lat. 66° 45′; being at the former 1.0280, at the latter 1.0263. In higher latitudes, or in confined seas, we cannot expect to find a uniformity in such results; for the influence of the ice in the one, and of situation in the other, are sufficient to conceal such minute differences. On referring to his valuable work, an examination of his experiments on the density of sea-water, at different depths, will confirm also the second inference. The few exceptions to it in Captain Scoresby's Table, may be explained by the influence of currents, and irregularities produced by the neighbourhood of ice, which is known to exercise a powerful influence on the atmosphere, and on the waters. In the prosecution of this interesting subject, no instrument appears more admirably adapted to procure water from any required depth, without chance of error, than that gentleman's *marine diver*; which, with simplicity of construction, unites every property than can insure accuracy and convenience in those delicate investigations for which it was intended by its ingenious contriver.

I am at a loss what reason to assign for the increased density of water brought up from considerable depths; unless, according to a suggestion offered by my friend Dr Brewster, it may be owing to the *imperfect elasticity* of water, which prevents its particles, when compressed by the superincumbent column, from regaining their original condition, when the pressure is removed. A curious series of experiments might be made on the mechanical compression of water, by employing the bathometer of Mr Perkins, the inventor of the method of multiplying copper-plates by engravings on steel. In this machine, water inclosed in a brass tube, the sides of which need not exceed $\frac{1}{10}$th of an inch in thickness, is compressed by a solid piston, sliding in a leather collar, and acted on by the superincumbent column when sunk in the depths of the ocean. This seems one of the simplest means of producing an immense pressure; and when conversing with Mr Perkins, I remember his stating that the piston did not exactly return to its original position, on bringing up the instrument.

LIVERPOOL,
December 9. 1820.

ART. XXXII.—*General View of the Monthly Mean Variation, and the Mean Monthly Diurnal Variation of the Needle, with Tables of the State of the Atmosphere at the time of the Magnetical Observations.* By Colonel BEAUFOY, F. R. S. In a Communication to Dr Brewster.

THE following Table contains the morning, noon, and evening monthly mean westerly variation of the magnetic needle. The columns marked "Diff." denote the increase and decrease of the variation in the same months of the different years.

GENERAL TABLE of the VARIATION OF THE NEEDLE in 1817, 1818, 1819, 1820.

1817.		° ′ ″	1818.		° ′ ″	1819.		° ′ ″	1820.		° ′ ″	Diff. ′ ″	Diff. ′ ″	Diff. ′ ″
April,	Morning,	24 31 52	April,	Morning,	24 34 06	April,	Morning,	24 32 36	April,	Morning,	24 30 38	+ 2 14	— 1 30	— 1 58
	Noon,	24 44 43		Noon,	24 44 50		Noon,	24 43 09		Noon,	24 40 29	+ 0 07	— 1 41	— 2 40
	Evening,	24 35 58		Evening,	24 36 36		Evening,	24 34 59		Evening,	24 31 58	+ 0 36	— 1 37	— 3 01
May,	Morning,	24 32 20	May,	Morning,	24 36 18	May,	Morning,	24 32 42	May,	Morning,	24 30 42	+ 3 58	— 1 36	— 2 00
	Noon,	24 42 35		Noon,	24 45 49		Noon,	24 41 22		Noon,	24 40 08	+ 3 14	— 4 27	— 1 14
	Evening,	24 34 45		Evening,	24 38 35		Evening,	24 34 10		Evening,	24 33 00	+ 3 50	— 4 25	— 1 10
June,	Morning,	24 31 09	June,	Morning,	24 33 47	June,	Morning,	24 31 28	June,	Morning,	24 29 50	+ 2 38	— 2 19	— 1 38
	Noon,	24 42 14		Noon,	24 45 11		Noon,	24 41 41		Noon,	24 39 16	+ 2 57	— 3 30	— 2 25
	Evening,	24 34 45		Evening,	24 37 40		Evening,	24 35 09		Evening,	24 33 48	+ 2 55	— 2 31	— 1 21
July,	Morning,	24 31 14	July,	Morning,	24 34 24	July,	Morning,	24 32 31	July,	Morning,	24 28 41	+ 3 10	— 1 53	— 3 50
	Noon,	24 42 06		Noon,	24 44 59		Noon,	24 42 12		Noon,	24 39 00	+ 2 53	— 2 47	— 3 12
	Evening,	24 35 43		Evening,	24 38 14		Evening,	24 35 37		Evening,	24 33 26	+ 2 31	— 2 37	— 2 11
Aug.	Morning,	24 31 16	Aug.	Morning,	24 34 40	Aug.	Morning,	24 32 33	Aug.	Morning,	24 30 25	+ 3 24	— 2 07	— 2 08
	Noon,	24 42 51		Noon,	24 45 58		Noon,	24 42 49		Noon,	24 40 00	+ 3 07	— 3 09	— 2 49
	Evening,	24 33 45		Evening,	24 37 50		Evening,	24 34 24		Evening,	24 33 14	+ 4 05	— 3 26	— 1 10
Sept.	Morning,	24 33 02	Sept.	Morning,	24 34 29	Sept.	Morning,	24 32 29	Sept.	Morning,	24 39 16	+ 1 27	— 2 00	— 1 13
	Noon,	24 41 36		Noon,	24 45 22		Noon,	24 41 35		Noon,	24 40 29	+ 3 46	— 3 47	— 1 06
	Evening,	24 34 38		Evening,	24 37 28		Evening,	24 33 27		Evening,	24 32 59	+ 2 50	— 4 01	— 0 28
Oct.	Morning,	24 31 06	Oct.	Morning,	24 35 36	Oct.	Morning,	24 33 27	Oct.	Morning,	24 39 00	+ 4 30	— 2 09	— 2 27
	Noon,	24 40 46		Noon,	24 43 28		Noon,	24 40 08		Noon,	24 39 33	+ 2 42	— 3 20	— 0 35
Nov.	Morning,	24 31 49	Nov.	Morning,	24 33 24	Nov.	Morning,	24 32 42	Nov.	Morning,	24 32 23	+ 1 35	— 0 42	— 0 19
	Noon,	24 37 55		Noon,	24 41 41		Noon,	24 38 43		Noon,	24 37 38	+ 3 46	— 2 58	— 1 05
Dec.	Morning,	24 34 03	Dec.	Morning,	24 37 04	Dec.	Morning,	24 33 29	Dec.	Morning,	— — —	+ 3 01	— 3 35	
	Noon,	24 38 02		Noon,	24 41 20		Noon,	24 37 20		Noon,	— — —	+ 3 18	— 4 00	
1818,	Morning,	24 34 02	1819.	Morning,	24 35 42	1820.	Morning,	24 34 06				+ 1 40	— 1 36	
Jan.	Noon,	24 39 57	Jan.	Noon,	24 39 54	Jan.	Noon,	24 37 54				— 0 03	— 2 00	
Feb.	Morning,	24 34 22	Feb.	Morning,	24 34 17	Feb.	Morning,	24 32 19				— 0 05	— 1 58	
	Noon,	24 40 51		Noon,	24 39 55		Noon,	24 38 07				— 0 56	— 1 48	
Mar.	Morning,	24 33 18	Mar.	Morning,	24 33 18	Mar.	Morning,	24 30 47				0 00	— 2 31	
	Noon,	24 41 37		Noon,	24 41 42		Noon,	24 39 33				+ 0 05	— 2 09	
	Evening,	24 33 47		Evening,	24 35 17		Evening,	24 33 45				+ 1 30	— 1 32	

MONTHLY METEOROLOGICAL TABLE, containing the Mean Height of the Barometer, Thermometer, and Hygrometer, (De Luc's), at the hour of the Morning, Noon, and Evening Observations of the Magnetic Needle; also the prevailing Winds, Quantity of Rain, Evaporation, and the Mean Heat of each Month, by a regular series of observations with a Six's Thermometer.

Month.	Barometer.	Barometer.	Barometer.	Thermometer.	Thermometer.	Thermometer.	Hygrometer.	Hygrometer.	Hygrometer.	Winds.	Rain.	Evaporation.	Mean Temper.
1817,	Inches.	Inches.	Inches.	°	°	°	°	°	°		Inches.	Inches.	°
April,	29.770	29.726	29.762	42.7	48.8	45.0	61.2	48.5	50.0	NE	- - -	- - -	- -
May,	29.286	29.269	29.286	50.1	57.4	50.2	58.2	52.9	53.6	SW	- - -	- - -	- -
June,	29.410	29.422	29.439	61.1	68.3	62.0	60.8	48.7	52.3	SW	- - -	- - -	- -
July,	29.368	29.612	29.349	56.7	65.3	59.4	64.3	55.2	59.2	SW	- - -	- - -	59.3
Aug.	29.310	29.320	29.322	57.3	63.0	59.1	66.9	54.6	57.1	SW	- - -	- - -	58.9
Sept.	29.516	29.522	29.489	56.4	62.5	58.0	70.9	54.7	60.9	NE	- - -	- - -	58.1
Oct.	29.541	29.475	- - -	43	49.6	- -	65.4	56.6	- -	NE	- - -	- - -	44.6
Nov.	29.518	29.501	- - -	45.7	51.2	- -	78.0	68.0	- -	NE	- - -	- - -	47.7
Dec.	29.130	29.121	- - -	35.4	38.0	- -	78.2	66.0	- -	SW	- - -	- - -	35.9
1818,													
Jan.	29.227	29.387	- - -	37.6	41.2	- -	75.1	68.8	- -	SW	- - -	- - -	37.9
Feb.	29.272	29.286	- - -	32.8	37.3	- -	74.3	65.9	- -	SW	- - -	- - -	34.9
March,	29.154	29.132	29.427	37.6	43.6	39.8	66.1	57.2	51.4	SW	2.330	2.570	39.7
April,	29.241	29.294	29.322	44.5	49.9	46.1	62.9	51.7	55.0	NE	3.750	2.590	45.8
May,	29.393	29.463	29.423	51.7	59.0	53.4	52.2	42.1	47.1	NE	2.455	3.770	52.8
June,	29.597	29.586	29.610	62.8	71.5	65.2	43.1	32.7	37.5	SW	0.330	6.980	64.0
July,	29.629	29.621	29.625	65.8	73.3	68.1	43.8	33.8	37.7	NW	0.670	7.015	67.1
Aug.	29.625	29.605	29.611	62.3	68.8	63.1	41.3	30.4	32.2	NW	0.491	7.030	62.5
Sept.	29.346	29.326	29.357	54.9	62.2	58.1	61.1	44.6	51.1	SW	3.120	3.400	57.7
Oct.	29.411	29.391	- - -	51.6	57.9	- -	70.4	57.1	- -	SW	1.384	1.970	53.8
Nov.	29.394	29.357	- - -	46.5	51.4	- -	77.7	65.2	- -	SW	2.412	1.080	46.7
Dec.	29.611	29.607	- - -	35.6	39.8	- -	79.5	65.5	- -	NE	1.215	0.530	37.0
1819,													
Jan.	29.670	29.301	- - -	36.8	42.3	- -	81.5	63.5	- -	SW	1.906	1.400	38.9
Feb.	29.172	29.166	- - -	38.2	42.6	- -	72.2	55.9	- -	NW	2.828	1.430	38.8
March,	29.386	29.682	29.333	42	46.8	46.3	65.3	52.2	51.4	NW	1.153	2.680	41.6
April,	29.321	29.332	29.329	49	52.7	48.7	53.5	40.6	49.6	SW	2.468	3.440	48.5
May,	29.440	29.435	29.489	54.8	61.1	55.5	48.9	37.3	44.2	SE	3.063	4.530	55.3
June,	29.462	29.452	29.456	57.4	62.2	57.3	53.5	44.6	49.8	SW	1.950	4.250	57.2
July,	29.233	29.539	29.556	62.1	68.7	63.0	57.0	44.9	52.2	NE	1.514	4.930	64.4
Aug.	29.599	29.579	29.565	62.8	70.9	65.1	66.9	48.6	60.0	NE	2.520	4.720	65.5
Sept.	29.511	29.518	29.519	56.7	62.9	58.1	79.2	64.7	67.5	SW	3.213	3.550	57.9
Oct.	29.370	29.362	- - -	47.7	53.1	- -	79.9	68.9	- -	NW	1.610	2.280	49.1
Nov.	29.253	29.233	- - -	37.4	42.0	- -	79.9	72.8	- -	NW	1.761	1.230	39.8
Dec.	29.243	29.288	- - -	32.4	36.4	- -	82.9	75.5	- -	SW	2.429	0.710	34.8
1820,													
Jan.	29.372	29.402	- - -	28.3	33.1	- -	80.2	73.9	- -	SW	1.020	0.360	31.3
Feb.	29.518	29.479	- - -	30.4	38.7	- -	82.9	74.1	- -	NE	1.143	0.765	35.6
March,	29.408	29.439	29.295	37.6	44.5	46.3	74.2	63.6	67.4	NW	0.246	4.170	40.7
April,	29.470	29.474	29.517	47.9	55.6	51.6	67.5	59.3	63.3	SW	1.505	3.750	49.5
May,	29.375	29.352	29.339	51.9	58.8	53.8	66.4	58.6	63.4	SW	3.383	4.270	53.4
June,	29.490	29.438	29.393	57.1	63.4	58.3	69.8	53.8	64.5	NW	1.724	4.391	58.1
July,	29.519	29.530	29.458	60.3	65.7	60.5	69.1	60.1	67.5	NW	1.936	3.950	60.7
Aug.	29.461	29.468	29.443	59.3	65.6	60.1	70.5	59.8	63.4	SW	1.992	4.820	61.1
Sept.	29.550	29.543	29.595	53.8	61.1	56.3	71.2	57.9	61.1	SW	2.282	3.400	55.3
Oct.	29.200	29.166	- - -	45.6	51.4	- -	71.8	61.9	- -	NE	2.538	2.500	45.5
Nov.	29.371	29.371	- - -	39.7	44.0	- -	76.7	70.0	- -	NE	1.223	0.853	41.6

ANNUAL METEOROLOGICAL TABLE of the Mean Height of the BAROMETER, &c.

Year.	Barometer.	Barometer.	Barometer.	Thermometer.	Thermometer.	Thermometer.	Hygrometer.	Hygrometer.	Hygrometer.	Winds.	Rain.	Evaporation.	Mean Heat.
	Inch.	Inch.	Inch.	°	°	°	°	°	°		Inch.	Inch.	°
1818,	29.208	29.421	29.482	48.7	54.3	56.3	59.2	51.3	44.6	SW			50.0
1819,	29.389	29.407	29.464	48.1	53.5	56.3	68.4	55.8	53.5	SW	2.6415	35.150	49.3

TABLE, containing the Morning, Noon, and Evening MEAN ANNUAL VARIATION of the MAGNETIC NEEDLE, during the Years 1818 and 1819.

Year		° ′ ″	Year		° ′ ″
1818,	Morning,	24 34 38	1819,	Morning,	24 33 06
	Noon,	24 43 26		Noon,	24 40 53
	Evening,	24 37 10		Evening,	24 34 43

TABLE, containing the MEAN MONTHLY DIURNAL VARIATION of the MAGNETIC NEEDLE, between Morning and Noon, and Noon and Evening, for Three Years and Nine Months.

MONTHS.		Years 1817, 1818.	Years 1818, 1819.	Years 1819, 1820.	Years 1819, 1820.	Mean.
1817,						
		′ ″	′ ″	′ ″	′ ″	′ ″
April,	Morning, Noon,	12 51	10 44	10 33	9 31	11 00
	Noon, Evening,	8 45	8 14	8 10	8 31	8 25
May,	Morning, Noon,	10 15	9 31	8 40	9 26	9 28
	Noon, Evening,	7 50	7 14	7 12	7 08	7 21
June,	Morning, Noon,	11 05	11 24	10 13	9 26	10 32
	Noon, Evening,	7 29	7 31	6 32	5 28	6 45
July,	Morning, Noon,	10 52	10 35	9 41	10 19	10 22
	Noon, Evening,	6 23	6 45	6 35	5 34	6 19
Aug.	Morning, Noon,	11 35	11 18	10 16	9 35	10 41
	Noon, Evening,	9 06	8 08	8 25	6 46	8 06
Sept.	Morning, Noon,	8 34	10 53	9 06	9 13	9 27
	Noon, Evening,	6 58	7 54	8 06	7 30	7 37
Oct.	Morning, Noon,	9 40	7 52	6 41	8 38	8 11
Nov.	Morning, Noon,	6 06	8 17	6 01	5 15	6 25
Dec.	Morning, Noon,	3 59	4 16	3 51		
1818, Jan.	Morning, Noon,	5 55	4 12	3 48		4 28
Feb.	Morning, Noon,	6 29	5 38	5 48		5 59
Mar.	Morning, Noon,	8 19	8 24	8 46		8 30
	Noon, Evening,	7 50	6 25	5 48		6 41

BUSHEY HEATH, STANMORE,
6th December 1820.

Art. XXXIII.—*Proceedings of the Royal Society of Edinburgh.*

Nov. 6. 1820. THE Royal Society resumed its sittings for the ensuing session.

A paper by Dr Butter was read, *On the Spontaneous Dispersion of Cataracts.* In this paper, the author gives an account of some cases that came within his own observation, where the crystalline lens, in its opaque state, disappeared spontaneously, independent of any injury or mechanical cause. These facts explain the remarkable circumstance of persons having recovered their sight without the aid of art. Dr Butter attempted to account for the spontaneous dispersion of cataracts by the following considerations. 1. By supposing some change to take place either in the quality or quantity of the aqueous humour. 2. Some loss of vitality in the lens, in its capsule, or in both, whereby it may be cast off from the surrounding parts. 3. Some morbid derangement in the tunic of the vitreous humour. 4. Some violent shock, or compression of the eye-ball, by its own muscles, of which the patient may not have been sufficiently aware, to refer it to a precise period.

Nov. 20.—A paper by Dr Dyce was read, *On the Nature and Properties of Alcohol, and on some Instruments for Measuring the Specific Gravity of Mixtures of Alcohol and Water.*

Nov. 27.—At a General Meeting of the Society, the following Gentlemen were elected Office-bearers and Counsellors:

Sir Walter Scott, Baronet, President.

Right Honourable Lord Gray, } Vice-Presidents.
Hon. Lord Glenlee, }

Dr Brewster, General Secretary.

James Bonar, Esq. Treasurer.

James Skene, Esq. Curator of the Museum.

PHYSICAL CLASS.

Sir G. Mackenzie, Bart. President. Alexander Irving, Esq. Secretary.

Counsellors from the Physical Class.

Dr A. Duncan *junior.*	Dr Hope.
Gilbert Laing Meason, Esq.	Professor Wallace.
Professor Russell.	Henry Jardine, Esq.

LITERARY CLASS.

Henry Mackenzie, Esq. President. Sir William Hamilton, Bart. Secretary

Counsellors from the Literary Class.

Reverend Dr Brunton. Hon. Baron Clerk Rattray.
Dr David Ritchie. Right Hon. Lord Chief-Baron.
Sir John Hay, Bart. Reverend Mr Alison.

At this meeting, the following resolution, moved by Dr Hope, and seconded by Sir George Mackenzie, Bart. was unanimously adopted, and ordered to be transmitted to Sir James Hall, Bart.

"The Royal Society having, in compliance with the wish of Sir James Hall, Bart. refrained from again placing him at their head, beg to avail themselves of this opportunity to offer him their best thanks, both for his long and zealous services as their President, and for the numerous valuable communications with which he has enriched their Transactions, and contributed materially to maintain the reputation of the Society."

Dec. 4.—Sir Walter Scott laid before the Society a letter, addressed to the President and Council, by Sir Alexander Keith, Mr Keith, and Dr Brewster, the trustees on Mr Keith's legacy (See this Journal, vol. i. p. 219.), offering to that Body the principal sum of L.600, the interest of which is to form a biennial prize, for the most important discoveries in science, made in any part of the world, and published for the first time in the Transactions of the Society. The prize is to be given in the form of a gold medal, not exceeding L. 15, 15s. in value, and a piece of plate, bearing the inscription and device upon the medal.

A notice by Dr Brewster was read, on the Distribution of Heat in the Arctic Regions. This notice was a continuation of his former paper on the Mean Temperature of the Earth; and the object of it was, to point out the remarkable agreement between the formula which he had formerly given and the observations of Captain Parry. He shewed that the pole of the globe was not the coldest point, but that there were two poles of *maximum* cold, situated at a distance from the pole, and in the meridians passing through North America and Siberia. He pointed out the agreement of this view of the distribution of heat, with the fine series of observations reduced by

Humboldt, and, by giving a position to the two poles, and assuming their temperature, he deduced a general formula for all meridians, and shewed, that the difference between the calculated and observed results were far within the limits of the errors of observations. The form of the isothermal lines resembles generally that of the isochromatic curves which surround the resultant axes of crystals with two axes of double refraction. In concluding this paper, the author pointed out the analogy between the magnetic and the isothermal curves in the polar regions: he noticed their similarity of position, and, conjecturing that these isothermal poles might have a motion of revolution round the pole of the earth, he shewed how, upon such a supposition, the low temperature of ancient Europe might be explained, and how we might account for the remains of plants, and land and sea animals being found in climates where they could not now exist.

At the same meeting, an account of the Journey of Alexander Scott, through Africa, drawn up by Dr Traill, was read. See this Number, p. 38.

Alexander Irving, Esq. communicated an extract of a letter which he had received, giving an account of the Earthquake which was recently felt at Leadhills. See p. 215.

Art. XXXIV.—*Proceedings of the Wernerian Natural History Society.*

Aug. 5. 1820. Mr Greville read a paper, containing an account of some of the Cryptogamous Plants of Devonshire, and communicating some new facts relative to several species of Fucus, particularly one discovered by Mrs Griffiths, so well known by her botanical researches. She had long observed, that when Fucus laciniatus occurred without the marginal processes, in which the seed-bearing tubercles are contained, the margin was of a darker colour than the rest of the frond: this, on a careful examination, proved to be formed by extremely minute single seeds. Mr Greville has since confirmed Mrs Griffiths's observation; and Fucus laciniatus must, therefore, be added to those which have two modes of fructification. During his stay in Devonshire, Mr Greville was fortunate enough to find Orthotricum Llyelii, which had never been detected out of the New Forest Hampshire, and also an abundant habitat for one of the most beautiful mosses peculiar to Great Britain, Bartramia arcuata. Among other observations on Fontinalis *squamosa*, Mr Greville mentions, that when dried, this moss has a very peculiar smell, not unlike that of some woollen-cloths before the oil is washed out. This smell, he adds, is never to be perceived in Fontinalis *antipyretica*.

Nov. 18.—A communication from Dr Barnes of Carlisle to Professor Jameson, was read, giving an account of an aged person in Cumberland (Mr Bowman of Irthington,) who has now completed his 115th year. (This paper is printed in the present Number of this Journal, p. 68. *et seq.*)

Professor Jameson then gave a general account of the Voyage of Discovery made by the ships Hecla and Griper, under Captain Parry. (This communication, in an enlarged form, is also printed in the present Number of this Journal, p. 144. *et seq.*)

At the same meeting, extracts of two botanical communications were read: 1. From Mr R. K. Greville's observations on the Flora of the Arctic Regions, with a description of a new species of Potentilla, (named P. Jamesoniana,) discovered by Mr William Jameson, surgeon, an active and intelligent naturalist, who has made two voyages to Baffin's Bay: 2. From Mr D. Don's Descriptions of several new plants from Nepaul. The following are the names of the plants described by Mr Don:

Rhododendron setosum	Delphinium scabrifolium
anthopogon	Leontodon eriopodum
campanulatum	Tragopogon gracile
Andromeda cupressiforme	Saussurea gossipiphora.
Lilium Nepalense	

Both of these botanical papers will appear in the Third Volume of the Memoirs of the Wernerian Society, about to be published.

Dec. 2.—The following gentlemen were elected Office-Bearers and Counsellors for the year 1821:

Robert Jameson, Esq. Prof. Nat. Hist. Edin. President.

Sir Patrick Walker,
T. Mackenzie, Esq. M.P.
Robert Stevenson, Esq.
David Falconar, Esq.
} Vice-Presidents.

P. Neill, Esq. Secretary, Wm. Ellis, Esq. Treasurer.
James Wilson, Esq. Librarian. P. Syme, Esq. Painter.

Council.

Thomas Sivright, Esq.	Wm. Newbigging, Esq.
Dr James Gregory *junior.*	Dr Samuel Hibbert.
Captain Thomas Brown.	Pat. Small Keir, Esq.
Colonel David Williamson.	Robert Bald, Esq.

Dec. 2.—Professor Jameson read an account of the progress of the Overland Expedition from the Settlements on the shores of Hudson's Bay towards the Arctic Ocean, and exhibited a chart of the north-west side of Hudson's Bay, drawn by an Esquimaux. (This communication will be found in our present Number, p. 141., &c.)

At the same meeting was read the first part of an Account of a Voyage into Baffin's Bay, by Mr William Jameson, surgeon.

Dec. 16.—Mr Adie exhibited, and read the description of, an instrument for ascertaining the specific gravity of bodies, without the use of weights or calculations. This instrument is equally accurate with the hydrostatic balance; but the operation of taking the specific gravity by it is much simpler, is done in a much shorter time, and the instrument itself is greatly cheaper. Experiments were made with it before the Society, to the satisfaction of all present.

At the same meeting, Mr John Deuchar explained the nature of an apparatus, suggested some time ago by Colonel Yule, for firing ordnance without the use of a light or the usual prime. Mr Deuchar also gave an account of a number of experiments performed with the above apparatus, several of which he shewed to the Society; in one of these the flame passed through three pieces of the wire-gauze used in Sir Humphry Davy's safety lamp; and in another was shewn the singular result of the flame passing through some gunpowder without setting it off.

Art. XXXV. SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Observations on the Solar Eclipse of September* 7. 1820. —Colonel Beaufoy made the following observations on the late solar eclipse at Bushey Heath, in West Long. 1′ 20″.93 in Time, and North Lat. 51° 37′ 44″.3.

	Apparent Time at Bushey Heath.	Temperature.
Beginning, - -	0h 22′ 57″	63° Fahr.
Greatest observation, -	1 52 45	61
End, - -	3 14 47	64

Mr Fox observed the end of the Eclipse at Plymouth in

West Long., - 4° 12′ 45″, and
North Lat. - - 50° 22′ 24″
Eclipse ended, - - 2h 58′ 56″ Apparent time.

Dr Burney observed the Eclipse at Gosport:

	Mean Time.	Temperature.
Eclipse began, - -	12h 16′ ½	70° Fahr.
Greatest obscuration, -	1 46 ⅔	61
Eclipse ended, - -	3 10	64

2. *Belzoni's Observations of the Annular Eclipse of the Sun, of the 5th May* 1818.— " Proceeding on my voyage, the next day, at about a league before we reached Acmin, on the 5th May 1818, at 8 o'clock in the morning, I saw the finest eclipse I ever beheld. The moon at its full passed completely before the sun. The eclipse lasted about *three quarters of an hour!* I saw the full moon in the centre of the sun, which formed a disc or ring. The moon appeared to me in the proportion of about *half the size of the sun!*" *Narrative of Operations, &c. in Egypt*, p. 289.

3. *Oppositions of the New Planets Ceres, Pallas, and Vesta, observed by Mr Groombridge.*—The following oppositions of the new planets, as observed by that excellent astronomer, Mr Groombridge, are published in the last part of the Philosophical Transactions.

VESTA.

1818.		Longitude.	Latitude.
April 3.	12^h 47′ 39″	200° 23′ 41″.8	12° 50′ 31″.8 N.
4.	12 42 50	200 8 52 .1	12 51 23 .5
12.	12 4 9	198 8 26 .5	12 51 55 .3
15.	11 49 35	197 23 37 .9	12 49 6 .0
17.	11 39 54	196 54 22 .4	12 46 24 .1

PALLAS.

1818.			
Sept. 1.	12^h 20′ 21″	347° 38′ 10″.3	7° 40′ 11″.7 N.
2.	12 15 40	347 22 45 .1	7 32 58 .6
6.	11 56 56	346 20 42 .6	7 3 9 .5
9.	11 42 53	345 33 48 .0	6 40 1 .3
11.	11 33 31	345 2 27 .3	6 24 12 .1
12.	11 28 50	344 46 50 .3	6 16 13 .0
13.	11 24 9	344 31 11 .5	6 8 10 .1

PALLAS.

1820.			
Feb. 1.	9^h 42′ 57″	99° 15′ 54″.7	48° 47′ 4″.0
4.	9 30 22	98 53 18 .1	47 46 32 .0
6.	9 22 9	98 41 59 .8	47 5 57 .5
10.	9 6 5	98 26 41 .6	45 36 37 .1
16.	8 43 1	90 24 49 .8	43 18 4 .7
17.	8 39 16	98 26 38 .8	42 54 19 .0

CERES.

1820.			
Feb. 1.	11^h 49′ 38″	122° 55′ 5″.1	12° 19′ 4″.7
4.	11 34 57	122 14 33 .3	12 25 4 .3
10.	11 5 54	120 58 39 .7	12 33 19 .8
16.	10 37 26	119 52 25 .4	12 36 37 .2
17.	10 32 46	119 42 33 .6	12 36 42 .6

4. *Obliquity of the Ecliptic.*—In the same paper, Mr Groombridge has published his observations of the solstices, in the years 1818 and 1819, from which he obtained the following results:

Mean obliquity in 1818, - - - 23° 27′ 47″.36
Mean obliquity of the Vernal Equinox 1819, 23 27 47 .03

See *Phil. Trans.*, 1820, p. 330.

MAGNETISM.

5. *Effect of Magnetism on the Balance of Chronometers.*—It appears from a curious paper by Mr Fisher, on the Errors in Longitude, as determined by chronometers at sea, that a sudden alteration takes place in the rates of chronometers, when taken on board of ships, an effect which has been generally ascribed to the motion of the vessels. He ascribes the acceleration which takes place to the "magnetic action exerted by the iron in the ship, on the inner rim of the balance, which is made of steel;" and in proof of this, he found, that analogous effects took place in chronometers when under the influence of magnets placed in different positions with respect to their balances. "Upon the whole, says Mr Fisher, it appears that chronometers will be generally accelerated (particularly if their balances have not received polarity by the too near approach of any thing magnetical) on ship-board. It appears probable, likewise, that the force of the balance-springs is affected in the same way, since it is well known that chronometers having gold balance-springs, although more difficult to adjust, yet keep better rates at sea than others."—*Phil. Trans.* 1820, p. 207.

6. *Diurnal Variation of the Needle, &c.*—The following interesting results are given by M. Hansteen of Christiania. 1. The magnetic intensity of the earth is subject to a diurnal variation, decreasing from day-break till 10^h or 11^h A. M., when it reaches its *minimum*, and from thence it increases till 4^h or 5^h P. M. It then decreases, and afterwards appears to reach a *maximum* about 3^h A. M. 2. Two or three days after the moon crosses the equator, the magnetic intensity seems to be weakened. The same happens during an aurora borealis. 3. The magnetic intensity is also subject to an annual variation, being greater in the winter than it is during the summer. 4. Every object, of whatever materials it consists, when suspended in a vertical position, has a magnetic north pole at its lower end, and a south pole at its upper end.

ELECTRICITY.

7. *Experiment in favour of one Fluid.*—M. Van Marum, in a Memoir, lately read at the Royal Institution of the Sciences of

Amsterdam, has given various interesting historical details respecting the adoption of the theory of two fluids by the French mathematicians. He considers that the discovery which he made in 1784, with the great Teylerian machine, of the *ramified form of the spark*, which passed from the first conductor to the receiving conductor opposite, affords an *experimentum crucis* in favour of the Franklinian theory of a single fluid. All the common electrical machines had produced only sparks that were *conducted and not ramified*, and hence it might have been supposed that the spark was a combination of two sparks moving in opposite directions; but it is not easy to admit such a supposition, when the spark is known to have the form of a branch, with the twigs all pointing to one of the conductors. A translation of Van Marum's paper is published in the *Annals of Philosophy* for December 1820, p. 140.

8. *Experiment in favour of two Fluids.*—M. Moll has lately performed an experiment, which has been considered as equally decisive in favour of *two fluids*. He places vertically a very thin leaf of tin between two insulated horizontal rods of brass, terminated by a button, and at the distance of one or two inches. The discharge of a strong electrical battery is then made to pass from the one to the other, and the plate of tin is found to be perforated with *two holes*, with the burrs or ragged edges in opposite directions. *Journal de Physique*, Mai 1820, p. 396.

METEOROLOGY.

9. *Meteorological Committee for procuring Meteorological Journals.*—The great importance of meteorological observations, (particularly of *thermometrical ones* made twice a-day, at 10 A. M. and 10 P. M.), not only in reference to the operations of agriculture and gardening, but in reference to various branches of general science, has induced the Royal Society of Edinburgh to appoint a committee of their number, not only for the purpose of establishing meteorological observations in various parts of the coast of Scotland, and along its principal valleys, but also to collect meteorological tables from all parts of the world. The following gentlemen have been named as the Committee:

Sir George Mackenzie, Bart. Convener.

Dr Hope,	Patrick Neill, Esq.
Professor Jameson.	Robert Stevenson, Esq.
Alex. Irving, Esq.	Dr Brewster.

We trust that the members of the Royal Society, and lovers of science in every part of the world, will second the endeavours of this committee, to obtain information so useful to their country, and to the general progress of knowledge.

10. *On the Cause of Regular Figures formed by Hoar-Frost on Windows.*—This curious phenomenon was ascribed by M. Mairan to the pre-existence in the glass of certain regular figures and lines generated during its formation, and he supposes that the particles of hoarfrost deposit themselves according to these figures. M. Carena, in a memoir *Sur le Givre figurée*, published in the *Mémoires de Turin* for 1813 and 1814, p. 56.—79. has overturned this hypothesis, and shews that the following are among the principal causes of the phenomenon. 1. The natural force of crystallization. 2. The necessity of the hoar-frost extending itself along a plane surface, which restrains the *quaquaversus* tendency of crystallization. 3. The numerous and varied resistances presented by the surface of the glass. 4. The imperfect and irregular conducting power of the glass, which is apt to produce in the vapours curvilineal motions at the instant preceding their congelation. M. Carena placed a small copper disc on the outside of one of the panes of glass, and found that the corresponding part of the glass was always free from hoar-frost.

II. CHEMISTRY.

11. *Carbonic Acid, &c. found in Sea-Water.*—M. Vogel has remarked, that Dr Murray and Dr Marcet have regarded sea-water as more simple than it really is; and that he has evidence, that the waters of the Mediterranean and the ocean contain *carbonic acid* and also carbonates of lime and magnesia. *Journ. de Pharmacie*, tom vi. p. 378.

12. *Muriate of Potash in Rock-Salt.*—M. Vogel has discovered muriate of potash in the rock-salt of Berchtesgaden, in Upper Bavaria, and in that of Hallein in Salzburg. When dissolved in water, and freed, by evaporation, of the greater

part of the sea-salt which it contains, it precipitated the muriate of platinum. The precipitate, when calcined with oil, and heated with nitric acid, gave crystals of nitrate of potash. The water of the Saline of Rosenheim in Bavaria, when evaporated, likewise precipitated the muriate of Platinum. See Vol. ii. p. 325. of this Journal.

13. *Apparatus for the Combustion of the Diamond, by Mr John Murray, Lecturer on Chemistry.*—" In the Quarterly Journal of Science and the Arts, No. 18. p. 264, 265, Mr Brande has described an apparatus for the combustion of the diamond, which is both complicated and expensive. In Plate III. Fig. 10. is delineated the apparatus which I employ for this purpose. Its simplicity may be considered its chief recommendation. It represents a glass globe filled with oxygen, obtained from oxymuriate of potassa over mercury. A portion of the stem of a tobacco pipe, attached to the curved end of a wire fastened to the cork above, carries the diamond, fixed in a nidus prepared for it. The diamond is kindled by the oxyhydrogen blowpipe, or a stream of oxygen urged over the flame of a spirit of wine lamp, and then immersed into the globe. When the combustion of the diamond ceases, lime-water is passed up into the recipient, and the weight of the carbonate of lime formed and precipitated, indicates the quantity of diamond consumed."

14. *On the Alloys of Platinum.*—Mr Murray has favoured us with the following observations on the alloys of platinum. " While operating on antimony, I had placed a small button of that metal in a platinum spoon, and introduced it into the flame of a spirit lamp. The antimony had scarcely attained fusion, when the platinum spoon, together with it, ran into an uniform brittle mass, and fell in vivid combustion on the glass lamp, which was consequently fractured. The effect in question is prettily exhibited by wrapping up a bit of antimony in platinum foil, and holding it by a pair of forceps in the alcoholic flame, when a beautiful ignition shortly commences, and the glowing mass falls to the ground. Fragments of grained tin, arsenic, lead, bismuth, &c. folded up in platinum-foil, exhibited at the instant of fusion and combination, very brilliant and

beautiful phænomena; but the finest effect certainly was that of zinc and platinum-foil, when the fused mass emitted an intense light of a blue colour. Alloys of tin and arsenic, bismuth and lead, &c. were in like manner subjected to experiment. Laminated gold, silver and copper, proto-carburet, and per-carburet of iron, pinchbeck, &c. were rolled up in platinum-foil, and introduced into the flame, but without any particular result. Remarkable and beautiful, however, were the phænomena which appeared, when some metallic wires were brought in contact with platinum wire at a white heat in this flame. Gold, silver, and copper wires were those used. They fused in the flame, and, when brought in contact with the platinum wire, severally produced minute adhering balls, which, repeated with narrow intervals between, appeared ultimately like little glowing beads threaded on a string. These united with the platinum, and burned with very delicate scintillation; and when the wire was inclined, the beads ran along the metallic string, combining with successive films of the wire, until the latter became as fine as the almost airy thread of the gossamer. The gold, silver, and copper wires, *per se*, entered into tranquil fusion, and did not scintillate. When zinc is carried along the platinum wire, the ends or streams of a fine blue flame ascend from it, and when the bead rather exceeds in size, jets of a similar coloured flame issue, accompanied sometimes with slight explosion."

15. *Fulminating Silver.*—" In preparing some fulminating silver," says Dr Gilby, " I observed an occurrence which I have not seen any where noticed. I had placed on the table a small portion of it, to shew its detonation, and it happened, from a hole in the paper, that several other small heaps were scattered on the table; in touching one of them with sulphuric acid, I was surprised to find that they all detonated spontaneously. It is easy to imagine several reasons for the circumstance, but I am not certain as to the true one. I have frequently repeated the experiment, and always with the same result *."

16. *Iodine in the Crab and Lobster.*—M. Chevreul has dis-

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* See this *Journal*, vol. I. p. 417.

covered Iodine in the bones of the head of the crab and of the large lobster, but he could not find it in the common lobster.

17. *Method of restoring the White Colours in certain Paintings.*—M. Merimée having observed, in a design by Raphael, that the lights had lost their brightness, applied to M. Thenard for his advice. This distinguished chemist ascribed the effect to the circumstance, that the white lead dissolved in water had become sulphuretted by the lapse of time, and had been changed from white to black; and having sent to M. Merimée some slightly oxygenated water, it was applied to the black parts, and the white colour was instantly restored. The water contained only five or six times its volume of oxygen. There is reason to think, that this method will not succeed equally well with oil paintings. *Journ. de Physique*, Mai 1820, p. 398.

III. NATURAL HISTORY.

BOTANY.

18. *Fig-Trees.*—In Scotland the fig-tree requires to be planted in a sheltered situation, and to be trained to a wall having a southern aspect. Without these precautions, the fruit would not ripen in ordinary seasons. But the necessary consequence of training to a wall is the production of strong and succulent shoots, the wood of which has not time to acquire firmness or maturity. Our Scottish fig-trees must therefore be covered during winter with screens composed of bass-matting, or of branches of spruce-fir, (which last have been found to be excellently adapted to the purpose.) In some of the finer districts of England, however, fig-trees succeed perfectly well as standards. In standard trees the growth of the wood is not so exuberant, and the wood which is produced acquires sufficient firmness to withstand the usual winter. Mr Henry Phillips, in his *Pomarium Britannicum*, lately published, gives us an account of a fig-orchard in the county of Sussex; and as a *figgery* may probably be a novelty to not a few of our readers, and as the account of it constitutes one of the best passages in Mr Phillips's book, we shall extract it. "There is an orchard of fig-trees at Tarring, near Worthing, where the fruit grows on standard trees, and ripens as well as in any part of Spain. These trees are so regularly productive, as to form the principal means of support

of a large family. Although the orchard does not exceed three quarters of an acre, there are upwards of 100 trees that are about the size of large apple-trees, the branches extending about twenty feet each way from the trunk. Mr Loud, the proprietor of this little figgery, mentions, that he gathers about a hundred dozen per day during the season, and that he averages the trees to produce him about twenty dozen each. The fruit, which is partly of the white and partly of the purple variety, ripens in August, September, and October; a time of the year when the neighbouring watering-places are frequented by fashionable company, that insures a ready sale for this agreeable fruit at good prices.—The second crop has occasionally ripened; the fruit, although smaller, is exceedingly sweet.—Two of the trees are now about seventy-five years old, having been planted in the year 1745, by John Long, who raised them from some old ones in an adjoining garden, near the ruins of the palace of Thomas-à-Becket in that town, who, tradition says, brought these trees from Italy and planted them himself. The soil of the garden is a deep black loam on chalk. The trees are but seldom and sparingly pruned. When they grow too luxuriantly, it has been found better to destroy a part of their roots, and to fill up the space with stones or broken bricks, than to prune the branches too much."—The effect of the juice or exudation of the papaw-tree of the West Indies in intenerating poultry or butchers-meat, is well known. From Mr Phillips we learn that the fig-tree possesses the same quality. "It is a curious fact," he says, "that fresh-killed venison, or any other animal food, being hung up in a fig-tree, when in leaf, for a single night, will become as tender and as ready for dressing, as if kept for many days or weeks in the common manner. A gentleman who lately made the experiment assured me, that a recent haunch of venison was hung up in a fig-tree at 10 o'clock at night, and was removed before sunrise in the morning, when it was found in a perfect state for cooking; and he adds, that in a few hours it would have been in a state of putrefaction," p. 169.

19. *Remains of Trees in the Orkney Islands.*—It has long been known, that some remains of roots and trunks of trees could be traced, at ebb tide, in a bay at Otterswick in Sanday, and in a similar bay at Deerness, in the south-east quarter of Pomona or

Mainland. In a former Number (vol. iii. p. 100.), we were enabled to describe a similar occurrence at Skeill, on the north-west of Pomona, and to add that the trees evidently belonged to the pine tribe. There can be no doubt, therefore, that in former ages the Islands of the Deucaledonian Sea were clothed with wood; and that the trees consisted chiefly of some species of fir, the hazel and the birch.

20. *Discovery of the Linnæa Borealis in Northumberland.*—The Linnæa borealis was found wild, growing luxuriantly in long runners, and covering a space of between twenty and thirty square yards, in an old fir plantation, near Catcherside, about three miles north of Wallington, Northumberland, in the beginning of September last.

21. *Sternberg's Flora of a Former World.*—The first fasciculus of Graf Sternberg's Flora of a Former World has been published at Leipzic. It contains thirteen figures of different unknown trees, of which many belong to the family of palms. All the genera enumerated in this valuable work, are met with in the coal-fields of Scotland and England, and we have observed one of them in a piece of sandstone brought from Melville Island by the discovery ships. The Calamythis pseudo-bambusia, figured in Table xiii. Fig. 3. is so completely alike in the jointed arrangement of its stem, &c., to the palmæ figured in 2. 5. and 6. in the Travels of Prince Newied in Brazil, that although the species cannot be determined, there is a perfect resemblance in the generic characters. The work is to be continued in fasciculi, if the present be well received. We have no doubt that naturalists every where will encourage a publication which promises so well, and which treats of objects so interesting to the geologist and the botanist.

22. *Plants and Animals living in the Water of the Hot-Springs of Gastein.*—A species of *Ulva*, named *thermalis*, grows and flourishs in the water of these springs, in a temperature of about 117° Fahrenheit; and it is said some ferns and several mosses grow in the fissures of the rocks out of which the hot water springs. We are further informed, that a land shell, the *Limneus pereger* of Drapernaud, thrives in the water of these springs, and at the same temperature as the Ulva therma-

lis. It is also remarked of these, as of many other hot springs, that if faded flowers be partially immersed in them they speedily revive, and that flowers in bud soon expand in this highly heated water.

23. *Remarkable Internal Combustion of the Trunks of Scots-Fir Trees.*—Dr William Howison, who visited the north of Russia in 1818, having observed many large trees of the Pinus sylvestris or Scots-fir standing erect in the forest, in a withered, or frequently in a dead state, was led to examine into the reason. He was not a little surprised to find, that in many cases, although the bark was entire, the interior part or wood of the tree was in a great measure *charred*. On inquiry he found, that this was occasioned by the travelling boors, in the sultry dry weather of summer, seeking the shade of large trees, and making fires for dressing their victuals over above the roots of the trees. Many of these roots lie near the surface, and as they abound very much with resinous matter, they readily catch fire. The fire seems to be propagated slowly, as in match-paper; a gradual and stifled combustion creeps onward, encouraged by the drought, and constantly fed by the empyreumatic oil of turpentine (or tar) which is produced by the heat, until the interior of the trunk itself be destroyed.

ZOOLOGY.

24. *Notice of a peculiar Habit of the Starling, (Sturnus vulgaris).*—"Among the singular and instinctive habits of the feathered creation, the fact of flocks of starlings alighting upon the ground in circles, is not one of the least curious, and though perhaps little known or noticed, is not uncommon. I have at different times watched large flocks of these birds, and have often noticed them alight in a circular form: Once I remember to have seen the birds composing a numerous flock, divide themselves into two companies, and each form a distinct circle. I have endeavoured, but unsuccessfully, to approach sufficiently near them, to notice whether or not they were couched on the ground, or standing; indeed, their extreme timidity renders any, but general observations, almost impracticable. They will sometimes, if undisturbed, remain a considerable time on the same place, where the circularity in which their excrements

are laid upon the grass, affords a demonstrative proof of their singular habit. The circles they form, though not of exact symmetry, are sufficiently so to excite notice; their diameters vary much, this probably depends upon the number of birds in a flock. The birds make the same twittering whistle when upon the ground, as when perched in trees or on reeds. When I have noticed them, they have generally alighted in pastures; some few times I have seen them in stubble-fields, but never upon fallow or new ploughed land. For what purpose Providence has endowed these creatures with so peculiar a habit, I am at a loss to imagine. I have sometimes thought, that the circles of a deep green colour, which we occasionally see in pastures, and which are known by the name of "Fairy Rings," might owe their origin to the fertilizing quality of the decomposed fæces of these birds *. This, however, is only conjecture. I mention it merely, that others interested in such pursuits, may make observations on the subject, which, when opportunity again offers, I intend doing."—*Letter from Mr Johnson, Hill Top, Wetherby, October* 1820.

25. *Notice of a prolific cross-breed between the common Cat and the Pine-Martin, (Mustela Martes).*—We find by the *Bibliotheque Universelle*, that there has been lately presented to the Imperial Society of Natural History of Moscow, an animal which appears to be a cross-breed, formed by the meeting of the common cat and the pine-martin, and the fur of which promises to be a valuable article of commerce. The specimen presented to the Society was sent from the Government of Penza, where the pine-martin is very abundant. The following history is given of the cross-breed.—A domestic cat disappeared from a house in Penza, and returned in some days in a state of impregnation. At the usual period the cat littered four young ones, two of which very much resembled the martin. Their claws were not retractile, as in the cat, and the snout was elongated like that of the martin. The two others, of the same litter, more nearly resembled the cat, as they had retractile claws and a round head. All of them had the black feet, tail, and

* I am aware that philosophers attribute "Fairy Rings" to the agency of atmospheric electricity, &c.; but this seems to be no more than hypothesis.

ears of the martin; and they killed birds and small animals more for the pleasure of destroying them than for food. The proprietor endeavoured to multiply this bastard race, and to prevent their intermixing with the other domestic cats; and his endeavours were completely successful. In the space of a few years he reared more than a hundred of these animals, and he made a very beautiful article of furriery of their skins. The specimen presented to the Society was of the third or fourth generation, and it retained all the characters of the first. The fur is as beautiful and as silky as that of the pine-martin, and it may, with some care, become an interesting object for commerce.

26. *Swainson's Zoological Illustrations*.—The Prospectus of this work, published some time ago, excited much expectation among those who were acquainted with the beautiful drawings of the author, and its appearance has justified their anxiety for its publication. Indeed, it may be said to commence an æra in the delineation of some branches of Natural History. Those conversant with birds, are well aware how few of the most magnificent ornithological works have a character of nature in the figures. With the exception of Wolf and Mayer's birds of Germany, Wilson's American Ornithology, and some of La Vaillant's works, especially his Birds of Africa, we scarcely know a great work in which the true arrangement of the feathers has been sufficiently attended to; and yet each genus, and even species of bird, has a very remarkable uniformity in the texture and disposition of the feathers. The drawing of the figures in the celebrated *Planches Enluminées* is, in general, execrable. The discovery of taking impressions from drawings upon stone, has furnished a powerful instrument to naturalists, whose drawings in former times were mangled by the ignorance of engravers. Mr Swainson's intimate acquaintance with the feathered tribes, renders his delineations perfect ornithological pictures; and this new art enables him to communicate them to the public without the intervention of another person. The consequence is an air of life and nature about the figures in his work which at once strike the eye of the experienced ornithologist. His intimate and scientific acquaintance with shells and insects renders

these departments of his work no less interesting; and we will venture to assert, that figures of such truth and elegance as are contained in the Illustrations have seldom issued from the British press. The descriptions are clear and comprehensive; and, though he follows the Linnean divisions as the grand outline of scientific arrangement, he is not so bigoted to the Great Master spirit, as to reject the obvious improvements and subdivisions introduced by the nice tact of modern naturalists. To these qualities, we may add, that Mr Swainson's long residence in various distant countries, give him advantages which few naturalists have turned to better account.

With these claims to public encouragement, we hope that he will be induced to continue a work which promises much for those departments of natural science. The work is so printed that each volume may be systematically arranged, when completed; or, should it extend to several volumes, each may be dedicated to a separate department of natural history.

27. *Selby's Natural History of British Birds.*—Prideaux John Selby, Esq. of Twizel House, member of the Wernerian Society, will, in a few weeks, publish at Edinburgh, the first fasciculus, in imperial folio, of a Natural History of British Birds. This gentleman, who is well known as a correct and indefatigable observer, possesses uncommon powers in the delineation of objects of natural history, and appears to rival in his etchings the most skilful artists in this department of natural history. We have seen the original drawings, and also the etchings, and feel convinced that Mr Selby's work will form the most splendid addition to the Zoology of Great Britain hitherto published. The figures possess a life and energy truly admirable: the feathers are delineated in a masterly style; and the legs and feet, parts so often indifferently represented in ornithological works, are drawn with great care and accuracy. In short, all the parts harmonise in so perfect a manner, as to present to the eye of taste pictures of uncommon beauty. The knowledge of natural history is now so widely spread, and its numberless charms are so generally felt by accomplished minds, that there cannot be a doubt of the success of such works as those of Selby and Swainson.

28. *Natural History of Sumatra and Java.*—There has lately arrived in London from Bencoölen, a large collection of the natural history of Sumatra, formed under the superintendance of that distinguished and enterprising officer Lieutenant-General Sir Stamford Raffles, and intended for the valuable Museum of the India Company. Last spring we had an opportunity of seeing the beautiful and interesting collection of the animals and minerals of Java, brought to England and deposited in the Company's museum by Dr Horsfield, who has much distinguished himself by his numerous and interesting researches in regard to the natural history of the islands of the Indian Ocean.

29. *Affinity of the Genera Echidna, &c. with Amphibia.*—It would appear from the anatomical investigations of Meckel, that the genera Myrmecophaga, Echidna, Ornithorynchus, and Bradypus, are very nearly allied to the genera of the class Amphibia.

30. *Respiration of the Alimentary Canal.*—Dr Pragge, in a late Number of Meckel's "Archiv für die Physiologie," has endeavoured to shew, that the Motus peristalticus is nothing else than the respiratory motion of the alimentary canal.

31. *Serpents with Two Heads.*—Aristotle, Ælian, Aldrovandus, Licetus, Lanzoni, and many others, mention instances of serpents with double heads, so that it may be considered as a kind of structure not very uncommon in this tribe of animals. Redi, the celebrated anatomist, kept a two-headed snake for a considerable time, and afterwards dissected it. He found that it had two hearts, two tracheas, and two lungs: the two stomachs united into a common alimentary canal; and the liver and gall-bladder were double. He further remarks, that the one head died seven hours later than the other. Very lately Dr Corradori at Ruto in Tuscany, informs us, that he saw a snake with two heads; and adds, it sometimes happened that the heads differed as to the use of their faculties; thus the one head would eat while the other was asleep.

32. *Stony Concretions found in the Human Muscular System.*—Tiedmann, in a late dissection, found numerous white earthy concretions in the body of a man fifty-eight years of age, who was a great brandy drinker, suffered much from the gout, and died of hydrothorax. These concretions, which were most abundant in the muscles of the extremities, were generally longish, rounded, and smooth, and from two to three lines in length. Concretions were also detected in the coats of some of the arteries. According to Gmelin, these concretions contained phosphate of lime, 73; carbonate of lime, 7; animal matter, 20; = 100.

33. *Hermaphrodite Butterflies.*—In the collection of insects belonging to Professor Germar, are the following hermaphrodites. 1. *Papilio atalanta.* The left side male, the right side female; the left pair of wings is smaller, and more deeply notched than the right. The left antenna shorter than the right.—2. *Papilio antiopa;* right side male, and left side female. The right antenna much shorter than the left.—3. *Papilio Phœbe;* left side male. Left antenna shorter than the right; and the left pair of wings smaller, but the colour and margin same as the right pair. Hinder part of the body same as in male.—4. *Sphinx euphorbiæ;* left side male, and smaller than the right or female side. The distribution of the colour is remarkable. The whole under side of the body is divided by a line, in the direction of its length; the male side is covered with a green powder, while the female side has a white antenna, rose-red breast, and the abdomen marked with white denticulations. —5. *Sphinx galli;* left side male; the right antenna and the right pair of wings longer than those of the male side; but there is no difference of colour in the delineation of the two parts.

MINERALOGY.

34. *Rock-crystals containing globules of Water formed, and forming, in decaying Granite in Elba.*—The granite of Elba is sometimes traversed by fissures, and these fissures are frequently filled with a disintegrated granite, in which, we are told, are daily forming rock-crystals, nearly all of which contain bubbles

of water; and sometimes there appears a vegetable-like matter floating on the water.

35. *Strontites and Precious Opal, &c. in the Faroe Islands.*—Vargas Bedemar, who has lately spent a year in examining the geognostic structure of the Faroe Islands, discovered strontites, in secondary trap; also opal, most frequently the precious kind, and but rarely the common or semi-opal; and he mentions having found adularia, heliotrope, and black flint, also in the trap rocks.

36. *Boué's Geology of Scotland.*—We have great pleasure in recommending this work to the particular attention of geologists. It is by far the best general account of the geognostic structure of Scotland hitherto published, and does infinite credit to the industry and learning of Dr Boué. We feel confident, that this young and enterprising observer will contribute in an eminent degree to the progress of geology, and continue to reflect honour on that school where he commenced his auspicious career.

37. *Mohs's Characteristic.*—An English translation by Professor Mohs himself, of his Characteristic, or Characters of the Classes, Orders, Genera, and Species, of Minerals, has been lately published at Edinburgh. This classical work is but the forerunner of the System of Crystallography of this profound naturalist. The perusal of the Essay on the Crystallography and Natural History System of Mohs, in this Journal, will be found very useful to those who study the Characteristic.

38. *Hausmann's New Mineralogical Work.*—Professor Hausmann, we understand, is at present printing a large work, "On the Forms of the Inorganic Kingdom," of which the first part will appear next Easter, and the second the following summer. Having finished this interesting work, he will next prepare and put to press an account of his geognostical investigations in the Alps and in Italy.

39. *Alpine Limestone same age as Oolite and Lias.*—In a letter from Count Breünner, we are informed, that he, along with Messrs Buckland and Greenough, obtained, by actual examination, five excellent sections of the Alps, which enabled them

to make out their geognostical structure. Professor Buckland has prepared a Memoir on this subject, which, besides many other interesting statements, will contain a series of facts, proving, that the great formation of *Alpine limestone* is of the same age with the oolite and lias of the English series.

40. *Discovery of Green Fluor-Spar in Banffshire.*—As fluor-spar is one of the rarest of our Scottish minerals, we are happy to have an opportunity of adding a new locality to those already known, by informing our readers, that James M. Hog *junior* of Newliston, has lately discovered a grey variety, associated with green antimony in a calcareous-spar, on Lord Fyfe's estate, near the town of Keith, in Banffshire. It occurs massive and disseminated, but was not observed to be regularly crystallized. Mr Hog found, that when exposed to heat it became remarkably phosphorescent.

41. *New Scottish Localities of Ores of Titanium.*—1. *Iserine.* This ore occurs along with iron-sand, in the form of a coarse powder, on the shore of the Loch of Triesta, in the island of Fetlar in Shetland. Both ores may be found imbedded in small grains in the primitive limestone in the neighbourhood. 2. *Common Sphene.* Small crystals of this ore occur with the preceding in the limestone of Fetlar. It is likewise found imbedded in the porphyritic gneiss, at Altaness, in the island of Burray, Shetland. 3. *Rutile.* This ore occurs in small crystals, imbedded in the gneiss of the island of Burray. It frequently occurs likewise in acicular crystals, traversing the crystals of quartz, which line the drusy cavities of amygdaloid, in Fife and Perth. In some cases the amygdaloid consists of trap-tuff, in others of porphyry or clinkstone. It occurs in great beds in the old red sandstone formation.—*Dr J. Fleming, Flisk.*

42. *Extraordinary mass of Platina discovered in Peru.*—A Negro slave in the gold mines of Condoto, in the Government of Choco, in South America, found a mass of platina of extraordinary magnitude, and which is now deposited in the Royal Museum, in Madrid. It weighs rather more than $1\frac{1}{3}$ pound, and is the largest piece of this metal hitherto met with. The large specimen brought from America by Humboldt, and depo-

sited in the King's Cabinet in Berlin, and which weighs 1085 grains, was also found in Choco. These facts allow us to hope, that platina may be found in its original repository somewhere in that country.

43. *Alpine Limestone of the Carpathians.*—Count Dunin Borkowski, during his journeys among the Carpathian Alps, observed the great formation of *alpine limestone* resting on a marl-slate, probably a variety of lias limestone.

IV. GENERAL SCIENCE.

44. *Earthquake at Lead-Hills.*—The following account of the shock of an earthquake experienced at Lead-Hills on the 29th of November last, is an extract of a letter from the overseer of the Scots Mining Company to Alexander Irving, Esq.: "We were alarmed here yesterday morning about eight o'clock by an uncommon sound, which was heard by the people both above and below ground. A shock was felt like that made by a very strong shot, attended by a rushing noise. The miners under ground were so alarmed as to think that the shafts or sumps were running together. A second shock, still stronger, was felt last night about half past eleven o'clock. I was asleep in bed, and was awakened by it. I felt as it were a great stroke upon the bed, and heard a rushing noise, which died away in a hollow sound, as if at a great distance. I cannot say how long it lasted, as I was asleep at the commencement; but it was over in a very short time."

45. *Fall of a Mountain into the Moselle.*—On the 8th July 1820, a part of the mountain called Sept-Heure, *(Sichen-Rithren-Berge,)* situated near the Moselle, in the circle of Cochenim, and ten leagues from Coblentz, fell into the river. It had for many years given indications of a progressive movement. More than twenty vineyards have been destroyed by it. Another mountain called the Chaudron, *(den Kessel,)* exhibits numerous crevices, and threatens to stop the course of the Moselle by its fall. *Journal de Physique*, Mai 1820, p. 399.

46. *Height of Snowdon, as determined by Mr Wollaston's Thermometrical Barometer.*—This ingenious instrument, which

measures heights by the temperature at which water boils, was employed by Mr Wollaston to ascertain the elevation of Snowdon and Moel Elio. The following are the results:

SNOWDON.

	Feet.
Height by thermometrical barometer from the north end of Caernarvon Quay to the summit, -	3546.25
Ditto trigonometrically, according to General Roy,	3555.4
Ditto barometrically, according to General Roy,	3548.9

MOEL ELIO.

	Feet.
Height by the thermometrical barometer from the north end of Caernarvon Quay, - - -	235 55
Ditto trigonometrically, according to General Roy,	2371
Ditto barometrically, according to General Roy,	2391.8

See *Phil. Trans.* 1820, Part II. p. 302.

47. *Clay-slate Axe found in a Whale.*—Mr John Murray has favoured us with the drawing forming Fig. 11. Plate III., and representing a piece of clay-slate which was cut out of the blubber of a whale in Davis's Strait by the carpenter of the "London" Greenlandman of Montrose. It had sunk to a depth of from 18 to 20 inches, and the wound had cicatrised. It is neatly ground, presenting the knife-edge, and seems to have armed an Esquimaux lance.

48. *Luminosity produced by Compression, Friction, and Animal Bodies.*—Our ingenious correspondent Mr John Murray has favoured us with the following observations and experiments on this subject: "In the account of the descent of the Glacier of Weisshorn, (Vol. III. p. 275.) the light which is said to have been observed, is considered as *electrical*, and as analogous to that which is developed by breaking crystallised sugar, &c. There are several luminous phenomena which it would be difficult to explain according to the usually accepted views of chemical theory. We may suppose some of them electrical, but the opinion would not be legitimate, until declared by experiment. Thus, when fulminating compounds are subjected to friction and percussion, or pure calomel, oxide of lead, and sulphur, are suddenly compressed in a mortar, light evolves in these; and

the same thing occurs when a drop of alcohol touches the fulminating platinum, as prepared by Mr Edmund Davy. Light is also emitted when the olive oxide of silver is thrown into oxygenated water, or when balls of oxygen are broken *in vacuo;* and similar manifestations take place when the gaseous elements separate from euchlorine; and chloride and iodide of azote. It likewise appears, that light evolves under circumstances that seem more directly connected with condensation, as when sulphur combines with potassium, copper and lead, at an elevated temperature, or when platinum and tin-foil unite before the blowpipe, and atmospheric air, oxygen, &c. are condensed in a glass cylinder by a piston. Light, therefore, in these experiments, seems connected with the formation of new compounds, or sudden extrication of chemical elements by condensation or expansion. I should, in much deference to the opinion expressed, be inclined to consider this phenomenon either as connected with the compression of a portion of the air, occasioned by the fall of the glacier, or the production of a partial vacuum, and subsequent sudden supply by the surrounding atmosphere; for when the membrane spread over the "bladder-glass" on the air-pump bursts by the superincumbent pressure, and the air rushes into the void, at the same instant a flash of light is perceptible, if the experiment be made in the dark. The luminosity of insects, as the *scolopendra, lampyris, fulgora* and *linceus, lunulus, cancer,* &c. is a subject of most difficult investigation. If the light of insects, &c. were electrical, it should be increased by *stimuli,* as oxygen, &c. which seems not to be the case. If phosphoric, it should not cease with the death of the animal, but rather continue, or increase on decomposition of the animal matter. It intermits, and therefore seems dependant on the will of the animal, or is connected with some mechanical cause, and apparently more with respiration than any other thing. Were it phosphorous, it should be expended in the progress of its slow combustion, and demand a continued supply, and constant creation of the phosphoric matter would be necessary. Any thing which implies material ignition is absurd; and it seems to be a phenomenon *sui generis* connected with a peculiar feature of animal physiology, as electrcity is with others. Th light emitted from sugar, when broken in the dark, is generally considered electrical, but upon what grounds I know not. In my own experiments, I never could discover any electrical exhibitions when sugar was insulated and broken, or suffered friction in contact with the gold-leaf electroscope and its condenser. It is not generally known, that if we simply break a piece of of loaf-sugar, or even sugar-candy, *between the fingers* in the dark, a flash of light appears. I find that the same phenomenon takes place with beet-root sugar as with that from the cane; and by continued friction of the fragments upon each other, a continuous light is kept up. This occurs also when the sugar is rubbed on alum, rosin, &c. or triturated in a mortar. When sugar is broken, or suffers friction in *water*, *alcohol*, or *ether*, light is in like manner manifested, as is the case also in *carbonic acid*, *oxygen* and *chlorine*. A bit of sugar was allowed to remain in nitrous oxide, and another fragment in chlorine. Both emitted light when broken; and in the latter it seemed more intense, and of an orange tinge."

49. *On the Luminosity of the Ashes of Wood steeped in solutions of Lime, &c.*—The following observations on this subject are communicated by Mr John Murray. "In Vol. III. p. 343. of the Edinburgh Philosophical Journal, Dr Brewster has detailed some singular instances of luminosity developed by wood, &c. when previously steeped in solutions of lime and magnesia. I have long observed similar phenomena, such as the increased light which takes place when shreds of paper, bits of straw, &c. are burned to *white ash*, or amianthus, talc, (when calcined), &c. and introduced into the outer margin of the flame of a candle. You may remember that Sir H. Davy had already pointed out that incombustible matters, as *asbestus*, &c. increased the light of flame, and he even suggested that it might be practically useful in this way; and though he has not attempted to solve the phenomenon, I do not think it a problem of much difficulty. In reference to the intense luminous star which appears between charcoal points in a powerful galvanic apparatus, when the circuit is formed, the charcoal is always primarily reduced to the white state noticed by Dr Brewster. The very brilliant light, too, exhibited by bringing magnesia and some of the other earths in contact with the flame of the condensed gases in the oxy-hydrogen blowpipe, seems explicable on the same principle.

It depends on the *incipient reduction of the metallic oxide*, as for instance, the transit *of a peroxide into a protoxide*, or a deutoxide into protoxide. I may cite an experiment which appears to be conclusive. Into a curved tube, over mercury containing hydrogen desiccated with muriate of lime, pass a portion of *deutoxide of barium*, and then apply the heat of a spirit-lamp; a brilliant light appears, the deutoxide becomes the protoxide, and protoxide of barium and water are the results. Just so it is with the magnesia, &c. in the oxy-hydrogen flame, and the earthy matter contained in the charcoal submitted to the action of galvanic agency. I should from hence summon a strong argument in favour of Dr Clarke's asserted reduction of some of the earths. Thus manganese (to illustrate the position) is reduced from a peroxide to a protoxide with no very high temperature; yet it demands exalted increments of heat to reduce it further into its reguline form, but we know it is done without electrical aid. I see no plausible reason why the *earths* may not be reduced by a supposable high temperature, without calling in galvanic agency.

50. *Spontaneous Combustions.*—The following account of a case of spontaneous combustion has been transmitted to us by Mr James Gullan of Glasgow. "Having read an article in your valuable work, November 5., on the spontaneous combustion of cloth, I send you an account of the following fact, which occurred in the year 1817. Having sold a respectable spirit-dealer a parcel of sample-bottles, I sent them to him packed in an old basket, the bottom of which was much broken; to prevent the bottles from falling through, I put across the bottom of the basket a piece of old packing-sheet, which had lain long about the warehouse, which was an oil and colour one, and was besmeared with different kinds of vegetable oil. About six or eight weeks after, the gentleman informed me that my oily-cloth and basket had almost set his warehouse on fire. The basket and cloth had been thrown behind some spirit-casks pretty much confined from the air, and about mid-day he was alarmed by a smell of fire. Having moved away the casks in the direction where the smoke issued, he saw the basket and cloth in a blaze. This fact may be a useful hint to persons in

public works, where galipoli, rapeseed or linseed oils are used in their manufactures, as it is an established fact, (though not generally known,) that these vegetable oils used on cloths, yarn, or wool, in the process of dying, and confined for a time from the open air, are very apt to occasion spontaneous fire."

In the Annals of Philosophy for November 1820, p. 390, an account is given of the spontaneous combustion of a barrel of oat-meal, by which the meal and barrel were totally consumed. The editor of that Journal "presumes that the meal had been somewhat moist, and that it had heated precisely in the same way as hay does when stacked moist."

51. *Description of the Mummy-Pits at Thebes by M. Belzoni.*— "The passage where the bodies are is roughly cut in the rocks, and the falling of the sand from the ceiling of the passage causes it to be nearly filled up. In some places there is not more than a foot left, which you must pass through, creeping like a snail on pointed stones that cut like glass. After getting through these passages, some of them 200 or 300 yards long, you generally find a more commodious place, perhaps high enough to sit. But what a place of rest! surrounded by bodies, by heaps of mummies in all directions, which impressed me with horror. The blackness of the wall, the faint light given by the candles and torches for want of air, the different objects that surrounded me seeming to converse with each other, and the Arabs with the candles or torches in their hands, naked, and covered with dust, themselves resembling living mummies, formed a scene that cannot be described. After the exertion of entering into such a place, through a passage of 80, 100, 300, or perhaps 600 yards, nearly overcome, I sought a resting-place, I found one, and contrived to sit; but when my weight bore on the body of an Egyptian, it crushed it like a bandbox. I instantly had recourse to my hands to sustain my weight, but they found no better support, so that I sunk altogether among the broken mummies with a crash of bones, rags, and wooden cases, which raised such a dust as kept me motionless for a quarter of an hour waiting till it subsided again. I could not remove from the place, however, without increasing it, and every step I took I crushed a mummy in some part or other.

Once I was conducted through a passage no wider than that of the body, and choked with mummies, and I could not pass without putting my face in contact with some decaying Egyptian; but as the passage inclined downwards, my own weight helped me on; however, I could not avoid being covered with bones, legs, arms, and heads rolling from above. Thus, I proceeded from one cave to another, all full of mummies, piled up in various ways, some standing, some lying, and some on their heads." *Narrative of Operations and Discoveries in Egypt*, p. 156.

52. *Antidotes against Poisons.*—M. Drapiez has found, that the fruit of the *Feuillea cordifolia*, is a powerful antidote against vegetable poisons. Dr Chisholm has mentioned, that the juice of the sugar-cane is the best antidote against arsenic.

53. *Expeditions to the Frozen Ocean.*—The patriotic Count Romanzow has again fitted out two new expeditions for the discovery and investigation of unknown countries. One of the expeditions is to endeavour to travel along the solid ice on the coast of Tschutksi from Asia to America; the other to ascend one of the rivers in the north-west coast, in order to penetrate the unknown space which is between Icy Cape and Mackenzie's River.

54. *State of the Ice off the East Coast of West Greenland in Summer* 1820, *as observed by Captain Scoresby.*—" The polar ice retains a position very similar to what it has presented during the last three summers; excepting, that in the parallels of 78°–79°, such a quantity of open ice has intruded, as to form a chain of connection between the main western body and the west coast of Spitzbergen. This state of the ice occurred in June. The western body was somewhat open to the southward of Lat. 76°, so that I was enabled to penetrate fifty or sixty miles, until the coast of Greenland was seen bold from the deck. We " took the ice," in Lat. 74°, and obtained a clear view of the coast, sixty miles in extent, on the 18th of July, our Lat. being 71° 20′, Long. 17° 32′ W. In this parallel, the longitude of the land is 19° 42′ W., as determined by chronometer, corrected by lunar observation, and

the position of Iceland, Faroe, Lewis, and Man, seen in succession soon afterwards. A formidable chain of fields and flows occurred mid-way between the land and the exterior ice; but to the westward of this chain, little interruption to the navigation was observed, the fields, flows and drift-ice that were there seen being widely scattered throughout the interior waters. Hence there was no obstacle to our proceeding to the very shore; and had we not been fully employed in the more important concerns of the fishery, I should most probably have landed. But having in this place met with numbers of large whales, we obtained a full cargo, consisting of seventeen of these animals, expected to produce 200 tons of oil, and found it a matter of prudence to make our way out of the ice. We escaped from a troublesome entanglement on the 31st July, after being for several days greatly hindered by a vast accumulation of heavy ice, and the general prevalence of thick weather. From the remarkable openness of the ice near the east coast of *West* Greenland, there appeared to be no difficulty after the chain of ice-fields was passed, of tracing the coast for many degrees of latitude, both to the northward and southward of the 72d parallel. We entered the ice in Lat. 74°, and escaped to sea in 69° 40′, after remaining about forty days amid the mazes of the ice. The east coast of Greenland, at the situation visited, very much resembles the west of Spitzbergen, differing only in the circumstance of its bearing a less burden of snow. The land is mountainous, the surface hummocky, and in general very irregular. Though the atmosphere was clear, on our nearest approach, yet it was so loaded with a transparent vapour of unequal density, that the distinct form of the hills could not be determined. The apparent form of the land varied every moment, so that the most curious and beautiful appearances, as well as the most grotesque figures, were assumed by the mountainous coast. Obelisks, towns, spires, ramparts, turrets, flagstaffs, and basaltic cliffs, were frequently represented in clear and distinct forms. Though this state of the atmosphere was unfavourable for certain observations, yet in the course of the day I obtained good sights of the sun for the latitude and longitude, and variation, and such a view of the coast as gave me a tolerable eye-draught of the coast, through an extent of sixty miles. It struck me with some surprise to observe, that on the 18th of July, (Lat. 71° 20′) after a mild clear day, a considerable hillock of ice formed on the sea. I never experienced such a circumstance in the highest latitudes, after the middle of June. The thermometer on the preceding day stood at 40°, 45°, and 48°; in the night it must have fallen below 30°. This curious fact is to be attributed to the loss of heat in the night, when the sun's altitude was little or nothing, while in higher latitudes at the same season, it retains a considerable altitude throughout the twenty-four hours, and thereby produces a more equitable temperature."—*Letter from Captain Scoresby.*

55. *Bottle found on the Coast of Brazil.*—" *Bahia,* 11*th July* 1820.—To the Editors of the Edinburgh Philosophical Journal. Gentlemen, We beg leave to hand you a copy of a paper forwarded to us by Messrs Lowes and Brown, Maçaio, in a letter dated 15th June. We are, &c. ARTHUR & PETER LOWE."—" *Maçaio,* 15*th June* 1820.—On the 10th instant, a messenger arrived to the Governor of this place with a bottle containing a printed paper, copy of which we inclose: it was picked up by a *Jangadeira* * on the 5th instant, on Barra Grande, about 63 miles to the northward of this port †."

" N° 33.

" The bottle which contains this card, was thrown in the sea in Lat. 12° 56′ S., Long. 29° 10′ W. at noon on the 1st day of April 1820, from the ship Ospray of Glasgow, which sailed from Greenock on the 20th day of February 1820, on a trading voyage round the world. Whoever finds this, is requested to insert a notice of the time and place, in some literary or political publication, with the view of establishing facts relative to the currents of the ocean. (All well)."

56. *Report on Scoresby's Account of the Arctic Regions.*—A report on Captain Scoresby's Account of the Arctic Regions, by Baron Portal, Minister of Marine and of the Colonies, has been published in the " Annales Maritimes et Coloniales," for July

* The owner of a small vessel called a *Jangada;* they are used for coasting and fishing.

† Maçaio is in Lat. 9° 42′; the longitude we have not ascertained.

1820, No. 7. We need scarcely add, that it speaks in the highest terms of this excellent work. It is now translating into the French language; and a whale-fishery is to be established from France.

PRIZES.

57. *Adjudication of the Copley Medal.*—The President and Council of the Royal Society of London, have adjudged the Gold Medal on Sir Godfrey Copley's donation, to Mr John Christian Oersted, for his discoveries respecting the connection between Electricity and Galvanism. See this Number, p. 167.

58. *Appropriation of Mr Keith's Legacy.*—An account of the establishment of a scientific prize with part of the legacy left by the late Mr Keith of Ravelston, will be found in this Number, p. 191. See also Vol. I. p. 219.

Art. XXXVI.—*List of Patents granted in Scotland since 11th August* 1820.

9. To Job Rider of Belfast Foundry, Ireland: — For "certain improvements which produce a concentric and revolving eccentric motion applicable to steam-engines, water-pumps and other machinery." Sealed at Edinburgh 31st October 1820.

10. To William Frith of Salford, county of Lancaster, dyer:—For "great improvements in the method of dyeing and printing various colours, so as to fix or make the same permanent or fast, on cottons, linens, silks, in hair, worsted, and woollens, straw, chip and leghorn." Sealed at Edinburgh 23d November 1820.

P. Neill, Printer.

THE

EDINBURGH

PHILOSOPHICAL JOURNAL.

ART. I.—*Account of the Captivity of* ALEXANDER SCOTT, *among the Wandering Arabs of the Great African Desert, for a Period of nearly Six Years. Drawn up by* T. S. TRAILL, M. D., F. R. S. E. (Continued from p. 54., and concluded.)

ABOUT a month after their arrival on the Bahâr, the party to which Scott belonged, having taken leave of some of the pilgrims by shaking hands, and kissing the top of the head, left El Tah Sidna Mahommed El Hêzsh, embarking in the same boat which brought them thither, and which had been, in the interval, employed in carrying over passengers as they arrived.

Scott remarked, that the opposite shore of the lake was not visible, even in the clearest weather, from El Hêzsh, on account of the lowness of the land. There being more wind than when they came, and it being fair, they placed two oars across each other by way of a mast, and spread on them a long narrow blanket, such as they wrap round their bodies, as a sail. They left the shore of El Hêzsh, a little after mid-day, and arrived on the opposite side at day-break the next morning, (as he supposes, about six o'clock). In this voyage they had the advantage of sail and oars, and continued under way all night.

Scott had no conversation with the boatmen during this recrossing of the Bahâr. On account of his refusal to change his religion, he was not permitted to speak to them, and was refused every indulgence.

On landing, they found that several of the camels had died, owing, as Scott supposes, to their having swallowed stones and gravel while feeding on the low bushes, which are so close to the ground that the animals could scarcely feed without taking up gravel with them; and considerable quantities of it were found in their stomachs after they were opened. As soon as the hire of the boat was settled, (which amounted to three camels for every family taken over and brought back,) the party set out on its return, by the same route which they had followed in coming to the Bahâr. They travelled for a month without any particular occurrence, until they came to the wood before described. While going through it, they saw some of the black people called Bambarras, who were armed with bows and arrows, and quite naked. The Arabs attacked the Negroes, and a short contest took place, when several of the Arabs were wounded, but at last the blacks were beaten, and eight of them made prisoners. These were brought to the tents, bound hand and foot, and the next morning carried away by the Arabs, who pursued their journey. The Negroes were *tattooed* or marked by three diagonal cuts on each cheek, and a horizontal one across the forehead.

After this the caravan travelled for about a month and a half over hard ground, with small hills, covered with low wild bushes, but without trees of any size; but there were trees of considerable magnitude in the low ground through which they occasionally passed. About this time they came to a large valley, where there had been much rain, and a considerable quantity of fresh water was in it. The trees and shrubs were quite green; there grew no grass, but a herb like the *green-sauce* of England, a flower like the *dog-daisy*, and a yellow flower about eight or nine inches high, of which the camels, sheep, and goats ate. The "*green-sauce*" and goat's milk were here the principal food of the party. They remained about six moons in this valley, during which time the men frequently went out to fight, and brought back camels, corn, &c. which they had plundered. When this valley could no longer afford food to their cattle, they sent a party to look out for another place of encampment; and when they had discovered a suitable spot, the whole party set out for it, taking three days to reach this new district. Here they remained two or three months without any thing remarkable occurring, until the trees began to lose their leaves, all the vegetables withered, and the ground dried up, when the whole caravan set out direct for El Ghiblah.

For a week or two they went over hard ground, and then came to sandy valleys, quite barren, and without any vegetable on them, except the palm-like tree El Myrreh before noticed. In little more than a week they got over this sandy district, and in about another week again arrived at El Ghiblah, but not in the exact spot from which they had taken their departure.

They pitched their tents, however, by some wells, and seemed to consider themselves at home. They always avoided going too far to the northward, for fear of being taken by the "*Moors*" or subjects of the Emperor of Morocco, between whom and the wandering Arabs, or Moors of the Desert, there is a deadly hatred and perpetual war. The tribe with whom Scott lived was often at war also with Arabs to the southward *. At El Ghiblah, the black prisoners taken in their contest with the Bambarras, were sold to some people from Wadnoon, who gave 80 dollars for each.

The tribe was now held in much greater estimation by their neighbours than before their journey into the interior, and the men were called Sidi El Hêzsh Hezsh. To Scott, however, this journey was a source of trouble; for since his refusal to turn Mahommedan, they treated him much more cruelly, beating him almost daily with sticks. This he acknowledges, however, sometimes arose from his sleeping too long in the morning, when they thought that he should be attending to their cattle.

Scott states, that the district in possession of the Arabs commences some distance from Wadnoon, and is divided into

* During these long journeys Scott saw various animals, not noticed in the preceding pages, as monkeys, squirrels, porcupines, wolves, foxes, leopards, which are cowardly animals, hares, deer, with and without horns, various kinds of wild cattle, and an animal like a bear. Birds were seen of the eagle species,—a large one of this kind Scott has seen to carry off young kids. There were different kinds of hawks and crows. He saw a bird like an eagle, but larger, which preys only on hares. There were many ostriches, *peacocks*, cranes, red-legged partridges, parrots, "green and red birds with long tails," a large *green* bird, with the under part of the bill like a spoon.

four parts. The northern *Till* lies about 100 miles south of Wadnoon, and has a small river called Ourerah, and a *ward* or valley running through it. The western part is named *Sachal*, is divided from *Till* by the large wad called *Zerrohah*, the one being from the other ten or twelve days journey *. This wad is only a part of a much larger district called also Zerrohah, which lies to the eastward of Till and Sachal. It is a high, but not mountainous land, and sends down a large wad, as above mentioned, which reaches to the sea.

The fourth division El Ghiblah lies to the south, and is divided from Sachal by the wad Seyghe †. The tribes are in general terms distinguished by the name of the district they usually occupy, as the Tille-eêns, the Sachal-eens, the Ghiblah-eens. In each of those divisions, however, there are particular tribes scattered, the special names of some of which he recollects, viz. the *Mujatts*, and Zurghiêm tribes, which dwell in Till, are always at war with the Ulled D'Leims. The *El Arosiem* and *Ulled Missebah*, which belong to Zerrohah. Those of *Toborlet* (into whose hands Scott fell when cast away,) of Lemmiheir, Fyeketts, Ulled Tiderary, Ulled Emouksor, and Ulled Emiâra, are all of Sachal, or, as it is sometimes called Sachara, and are considered a very peaceable people. In El Ghiblah are the tribes of Ulled D'Leim, Ulled Edouochala, Ulled Teggadow, Ulled Emouss. Scott mentions also the Arab tribes of Orghebets and the Scarnas, who belong to El Sharrag, near the Bahâr El Tieb. These distant tribes he has seen, the former often, the latter sometimes, in El Ghiblah and in Sachal, having come there on fighting expeditions, or for corn. This appeared to him less extraordinary, because his own master was once absent for more than twelve months on an expedition of some kind; and the people of El Ghiblah sometimes go far to the southward, to a place called *Llumgaufra* ‡, the chief man of which is called Wildibacaab, and whence the

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* In this account there is some indistinctness, as we have not been able to ascertain from what point in Till to what point in Sachal this computation extends.

† It was on the coast of Sachal that the Montezuma was wrecked.

‡ In spelling this name, the Welsh double *Ll* has been adopted to give an idea of the sound.

Arabs obtain black slaves in exchange for horses, in the proportion of three or four slaves for each horse. These slaves are again sold at Wadnoon. Scott was also told, that at Llumgaufra there is a very large river, which runs a long way through the country; and that on the other side of this river the people are not Mahommedans *. He could not obtain any name for this river, but the general one of *Bahar El Tieb;* which is not, however, applied to small rivers. The name for them is Illimon Sacharah, or running waters.

Scott found that hostilities are also commenced by the Arabs; for the Blacks never come in a hostile manner amongst the former.

The Arabs generally remain in the place where they pitch their tents, as long as the herbage affords sufficient food for their cattle. When this is exhausted, or dried up, the tribe removes, and some of the sheep and goats are killed and eaten. The skins of these are taken off with particular care. The head is first removed, and while the body is yet warm, the hand is introduced beneath the skin of the neck, and worked round until the two forefeet are drawn out. The skin is then stripped off, so as to be without any cut on it, and thus forms a sort of bag, which is used to carry water or other liquid †.

The dress of the Arab men is nothing more than a blanket or shawl which is folded around them. The thick strong ones are called *Lixsa,* the thin ones *Haïck.* The turban is worn by those called Sidi, who are generally elderly people ‡; and also by the chief men of the tribe, either old or young.

The women wear the same kind of blanket, the corners being fixed over the shoulders by silver clasps, and secured by a belt round the middle. They have generally blue linen on the head. The women of the wandering tribes do not use veils. Their persons are slender, and the old ones are much wrinkled.

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* Is this river the Niger?

† This practice appears to be extremely ancient. The present Spaniards adopt it, probably from their Moorish conquerors, and in such bags wine is carried from one place to another through the whole peninsula.

‡ Are they not the descendants of the family of Mahommed?

The Arab marriage among these wandering tribes is not attended with any particular forms. A man inclined to take the daughter of his neighbour to wife, applies to her father, and generally gives him a number of camels. The number of these may amount perhaps to ten. This concludes the match, and the girl lives with her husband. Scott thinks that the parties may separate at the pleasure of either; and a man may have as many wives as he chuses to maintain. Both boys and girls are much fairer than when the skin has been exposed to the weather in advanced life. The sexes come quickly to maturity, and girls are sometimes married at ten and twelve years of age.

The funeral of these Arabs is not attended with any particular ceremony. The body is washed, and placed in the ground, on the same day that the person dies, and bushes and stones are placed over the grave, to preserve it from wild beasts.

Children are taught to write with black ink, formed of charcoal and milk, and applied to a smooth board, with a split cane or reed, by way of a pen *.

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* Scott was so taught; but from specimens of his skill which he has exhibited, he does not appear to have derived much advantage from his instructors. His proficiency does not now reach to the formation of all the characters of the Arabian alphabet. He can, however, write several of the letters, and repeat the names of the rest; but his attempts at writing shew him to be by no means an expert penman. He, however, probably speaks the dialect of El Ghiblah, which is said to be a corrupt Arabic, with fluency. The following list of a few names of things is noted down, as nearly as the ear can collect the sounds from his mode of pronouncing the words. There, as in the other proper names introduced into this narrative, *ch* is strongly guttural, the simple vowels have the sound of the Italian vowels, the final *e* is pronounced, and the accents are introduced to convey an idea of Scott's pronunciation.

Sun,	Simse.	Oil-Tree,	She-dãer-gãen.
Moon,	Gammáh.	Oil,	Zât.
Stars,	Injour.	Fig-Tree,	Kara-mõos.
North.	Till.	Prickly-pear,	Teckanīret.
East,	Sharrag.	Chinny or Archil,	Tomkilet.
South,	Ghiblah.	Dog,	Kelb,
West,	Sáchal.	Fox,	Vîl or Thîb.
Valley which has a stream or river in it,	Wad.	Wolf,	Zubâh or Athhăbah.
		Tiger,	Gurrzahẽc.
Gum-Tree,	Tolch.	Lion,	Sebáh.

In ten or twelve days after the arrival of the tribe in El Ghiblah they went on a plundering expedition, taking Scott along with them. Their arms were muskets, and a weapon of the sabre shape, not so long, but as broad as a sword, which had a sheath and handle of brass. The chief of the tribe had a brace of pistols, and a sword, which had belonged to the Montezuma. In three days they reached the tents they wished to plunder, and meant to attack them in the night; but the dogs gave the alarm and prevented the surprise, and the two tribes fought in the morning. Scott's companions beat the other party, killed several of them, took their camels, and burnt their tents; but in five days afterwards they were attacked and beaten by their adversaries, obliged to fly, leaving all their property behind them, and took refuge in the Wad Seyghi, close to the sea-shore. There they remained two months, and were at one time almost starved for want of food; at which time, Scott says he was of essential service to them; for the Arabs have so great a dislike to salt-water that they will not wet their feet with it if they can avoid it; and, should this happen through necessity, they take the earliest opportunity of washing their feet with fresh water; but fish being now their only resource, Scott was lowered down from high rocks to the beach, where he collected mussels and fishes for them.

At length they departed from Wad Seyghi, got a fresh supply of arms, and went in search of their old enemies, whom

Male Camel,	Ishmaël.	He-Goat,	Artroos.
Female Camel,	Annâg.	She-Goat,	Llang.
Young Camel,	Achwâr.	Ram,	Kabsh.
Goat,	Mâz.	House,	Dâr.
Sheep,	Nâzshe.	Water,	Illimah.
Deer,	Rozëlléd.	Elephant,	El Hâzsh.
Fish,	Seheut.	Moving Sand forming hills,	Loggrhâd.
Christian or Infidel,	Kaffre.	Rocky Mountains,	Kuddeah.
Christian,	Nazerenne.	Tree,	Sadrhu.
Christian boy,	Inferanne.	Date-Tree,	Unghól.
Ship,	Saffina.	Date,	Attomór.
Boat,	Zourgos.	Gold,	Edhéb.
A Man,	Ærak arózshel.	Moorish Soldiers,	Umhal ta Sultân.
A Woman,	Ærak hellemaráh.	Ostriches,	Nâm.
Cow,	Bagg væ or libgher.		

they found and attacked in fourteen days, but were resisted. In this action Scott was placed near his master, who threatened to kill him if he did not fire his piece, (having on a former occasion omitted to do so.) The head man of the enemy came towards Scott's master, who drew a pistol and shot him. Another, in the mean time, advanced on Scott, who was ordered by his master to fire, which he did, and the man fell from his horse. The rest of the party were soon beaten and dispersed. It was on this occasion given out that Scott had killed the chief of the enemy, which was not true; however, he was considered worthy of a particular name, as having slain an enemy in battle; and, instead of calling him *Christian* or *Alewk*, (their mode of pronouncing the abbreviation of his name, which he had told them,) he was afterwards styled "*Mahommed the Christian.*"

On another occasion, three Arabs were sent with Scott on a plundering expedition. On arriving at the enemy's tents, they waited till about day-break, meaning to steal what they wanted; but on approaching, a dog barked, and they fled, but were pursued and taken prisoners by some of that tribe, who carried them to their tents, deprived them of their arms, and detained them three days, threatening to murder Scott. In the middle of the third night, one of Scott's companions looked out of the tent where they were confined, and perceived the guards asleep. Accordingly, they endeavoured to make their escape; and leaving the tent, saw five men with guns, all fast asleep: they took the arms and slew the men; seized twenty-seven camels, and made off, but were pursued and overtaken, when one of Scott's companions was killed, another wounded, and he with the other escaped with difficulty. After wandering five days without any provision but what herbs they could find, on the sixth they reached their own tents.

Soon after this last adventure, Scott having, while watering the sheep at the wells by the sea-shore, seen a brig at sea, conceived the idea of making his escape, and ran away: he took shelter for the night in a cove among the rocks, which, from some foot marks at the entrance, he supposed might be the den of some wild beast *. He was, however, traced by the prints

* It is probable that the dread of being overtaken by the Arabs overcame every other fear; but Scott attributes his resolution, in part at least to a belief

of his footsteps, and retaken by the Arabs, who severely bastinadoed him on the soles of the feet, which they struck with a hot iron rod, so that it was two or three months before he recovered from the effects of this punishment *.

From this period until his final escape, he was kept with the tribe, wandering from place to place, to procure food for their cattle; they often attacking the neighbouring tribes, and being frequently attacked by them, sometimes beaten and plundered, at other times victorious, and robbing their enemies. In the latter end of July, or beginning of August 1816, the tribe encamped in a place called Lah Thinn, a little to the southward of the Wad called Ourerah, in the district of Till; Scott was, as usual, tending the sheep and goats, accompanied by his master's daughter. It happened that they both fell asleep. In the mean time a "wolf" came, killed three sheep, and dispersed the rest of the flock, so that when Scott and his companion awoke, the dead sheep were those only in sight.

Fear of the punishment which this negligence would certainly draw down on him, seconded his resolution to attempt an escape. He desired the girl to go and look for the sheep in one direction, while he searched for them in another. He instantly fled towards the sea-shore, along which he travelled for four days and nights in a northerly direction.

During this time his only sustenance was a little fresh water. Early on the fifth day, he saw to the eastward a great smoke, and some high mountains: he made the best of his way towards the smoke, and when in a hollow, near some houses built of stone, whence the smoke proceeded, he was met by a *Moor*, who pointed his gun at Scott, and desired him to throw away his knife, and take off his clothes. "On his refusal the man threatened to shoot him, when Scott said he might fire if he chose." Hearing himself addressed in the Arab tongue, the man put

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that some gunpowder which he had about him was a sufficient protection, even against a lion, which is said to have the greatest antipathy to the smell of it.

* Scott has been repeatedly asked whether, on this or any occasion he observed any thing peculiar in the appearance of his wounds, especially whether those on his shins (which were not uncommon,) shewed the *bone white*, but he says that his wounds were all *red*, though many of those on his shins were severe: all healed easily.

aside his musket, and asked Scott who he was. His question was briefly answered, when the Moor advancing, took Scott by the hand, told him he was safe, led him to his house, and gave him food.

He afterwards desired Scott to write to the English Consul at Mogador; and Scott did so. This man, leaving Scott under the care of his brother and his son, set off with the letter; and after an absence of eight days, returned with a letter from William Willshire, Esq. the English Consul at Mogador *, who sent a horse for Scott to ride upon, and 27 dollars to buy provisions.

After recruiting himself for three days longer, Scott, accompanied by the Moor, set off, and arrived safe at Mogador in five days, during which they travelled at the rate of at least thirty miles *per* day.

As the place where Scott encountered the Moor is not above a mile and a half from Wadnoon, that place may be considered as about 150 miles from Mogador. Near the Moor's house was a river as large as canals usually are in England. This river flows through the town of Wadnoon, and is fresh until it meets the tide from the sea.

From the neighbourhood of Wadnoon, Scott saw to the eastward mountains whose tops were covered with snow, which he was told remained on them all the year round †.

At Mogador and at Wadnoon, the language spoken is called (by Scott) Schlech ‡. He received every kind attention from Mr Willshire, during his stay at Mogador, who paid his ransom to the Moor, on account of the Ironmongers' Company of London. Scott reached Mogador on the 31st August, left it on the 11th of November, in the Brig Isabella of Aberdeen, Captain James Cummings, and got to London on the 9th of December 1816.

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* The humane attention of this amiable gentleman is gratefully acknowledged by Scott, Riley, and other unfortunates, and the willingness with which the Moor entered into Scott's restoration to freedom, is the best proof of the fidelity with which the important office of redeeming Christians from slavery, is executed by the representative of Britain at Mogador.

† The ridge of Atlas.

‡ Major Rennell thinks this may be *Shilha*.

Art. II.—*Observations on the Geography of Mr Scott's Routes in North Africa.* By Major Rennell, F. R. S. &c. &c.

The Geographical notices contained in this narrative are scanty, but appear to contain internal evidence of their truth. The most important part of them relate to the nature of the *Sahara*, in the place where the traveller crossed it; that is in its widest part; and which no other European, that I know of, has hitherto given an account of. We have been accustomed to regard the Sahara as having a continuous surface of loose sand, of forty to fifty caravan journeys across; but here it appears that nearly two-thirds of it have a much firmer surface than sand: and valleys occur in which large trees are growing. However, no grass, nor any drinkable water, is found there, (on the surface at least), the soil being highly impregnated with salt, which is, indeed, the common character of the *northern belt* of Africa.

The place where the Montezuma was wrecked can only be approximated, and that by an inquiry which may appear tedious to ordinary readers. But it happens that the place of the wreck, is the only *point of departure* that can be referred to in the arrangement of the position, from whence the route across the Great Desert or Sahara sets out. Scott himself only says generally, that the ship was wrecked between the Capes of Nun (or Noon) and Bojador, and within the province or district of *Sachal.* This is one of four contiguous provinces in this quarter, whose positions are described in the narrative: it is included between *Till* on the north, and *El Ghiblah* on the south; all the three extending along the coast of Africa, to the southward of *Morocco;* and having a small portion or *tongue* belonging to the *fourth* province named *Zerrohah*, (which lies inland) intervening so as to form a common boundary between *Till* and *Sachal.* This narrow portion of *Zerrohah* consists of a *Wad* or valley, which has a streamlet of water in it, and serves as a communication between the body of the province itself and the sea coast. It is named from the province to which it belongs, the *Wad* or Valley of *Zerrohah.*

The shipwreck took place at eight or nine hours camel travelling, (or about twenty English miles) from this valley; and to the southward of it, of course, because the shipwreck happened on the coast of *Sachal*, of which the valley itself has been described to be the northern boundary.

The province of *Till* is known to extend northward to the neighbourhood of *Nun*, (a cape and town well known in African geography); and southward it includes the valley of Ourerah, often mentioned in the course of the narrative, and from whence Scott finally escaped to Nun, after four days and nights travelling, and a part of the fifth day; and probably as fast as he could go. Allowing, then, that he went in *direct* distance 100 to 110 geographical miles in a direct line, this will place *Ourerah* at that distance to the south-west of Nun, and directly opposite to *Fortaventura*, the nearest of the Canary Islands to the Mainland of Africa; and a little to the northward of Cape *Juby* *. How far the province of Till may extend to the south of Ourerah, is not known, but probably not far, as so large a part of it lies beyond Ourerah, to the north-east; as also from the circumstance of the general *trending* of the coast in that quarter, as it bore on the supposed cause of the shipwreck. For this was doubtless the operation of a *south-easterly current* on the ship, which had carried her gradually, though imperceptibly, towards the land, all the way from the parallel of Cape *Finisterre* †. As her course would naturally be south-westward, that part of the coast which trends to the *westward*, was more likely to have arrested the ship's progress, than that which has a *southerly* direction; and this change of position takes place not far from Cape Juby. It seems probable, therefore, that the ship was stranded *thereabouts*; (and, indeed, most of the shipwrecks happen in this quarter). Had the ship been farther to the south, its course would have carried it parallel to the coast, and within sight of land, during the preceding day; whereas it was probably to the north of Cape Juby, during that day, where the land retires far back to the eastward, and out of sight.

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* It may be that the *Arca* of M. Delisle is meant for *Ourerah*.

† See the remarks on this current in the following Article.

Thus, we are induced to look for the place of shipwreck, and in consequence for the valley of *Zerrohah*, in the quarter of Cape Juby; and which opinion receives strength from the circumstance of *Ourerah* being in the vicinity of Cape Juby.

By the narrative it would appear, that seventeen days were employed between the place of the wreck and *El Ghiblah*, an encampment not far from the sea-coast, in the province of the same name, and stated to be the southmost of the four provinces occupied by the wandering Arabs, with whom our traveller had communication. If this journey of seventeen days is calculated on the ordinary rate of caravan travelling, 250 or 260 geographical miles in a straight line may be allowed; and these will reach to the River *Del Ouro* of the Portuguese. If fifteen instead of seventeen days, be the true reading, (as it appears doubtful in the MS.) thirty miles should be deducted; and the camp of *El Ghiblah* placed so much farther to the northward. But this will scarcely affect the general line of the route across the Great Desert. *Caravan rate* is here taken, because the party was so small; it consisting only of *one* family, attended by *three* camels; whereas the journey across the desert was performed by a large party, with 2500 animals of different kinds; and, moreover, was continued more than six times as long. The time employed in this journey is roundly given in *months*, with the exception of three intervals of eleven, five and two days; of course no accuracy is attainable. Most probably the new moons regulated his time; but, after all, the memory was to be trusted, and it would be unreasonable to expect a more consistent result than the one about to be reported.

The total number of days may be taken at 106, unless the three days halt in the wood, are to be included in the gross number of days given for the march *.

Considering that the party was composed of 115 to 120 persons, men, women and children, (Patriarch fashion), and that the latter classes did not *always ride;* moreover that there were

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* The time given for their journey back, does not materially differ from the other; it being, as well as the loose manner in which it is given (and probably could only be given) only *a few days short of it.* This tends to shorten the surplus distance arising on the calculation which follows.

about a thousand goats, (besides as many sheep, and 500 or 600 camels), which goats could only keep up with the camels *when they had sufficient food*; that camels travel only at the rate of 2½ English miles *per* hour; it is probable that 2 or 2¼ might be the rate of march, since the slowest goers must of necessity regulate it *. It must also be taken into the account, that nearly two-thirds of the way was not *sandy*, and therefore not so well suited to the feet of the camels, a great number of whom were loaded. No halts are spoken of, (except the three in the wood, on an extraordinary occasion); and it appears probable, that their daily marches were so short, as to enable them to persevere, without incurring such a degree of fatigue as would induce the necessity of frequent halts.

Perhaps, then, their rate was below that of great armies, which has been calculated at a mean, on marches of long continuance, at about 14½ British miles on ordinary roads: and when reduced to *direct* distance and geographic miles, at about 10½ each day. Perhaps, in this case, 10 may be amply sufficient.

This report of the general direction of the line of the route, cannot be expected to be more accurate than that of the distance, perhaps less so. The sun, however, would furnish him with a good mark, mornings and evenings, if he made allowance for its great declination at that season; for it was about the month of June when they set out. At their outset, it is said that their route was a little to the *southward* of *east*, and *gradually inclined more* to the south as they advanced, which is as clear as could be expected. If, then, we suppose a curve of this kind, it will terminate in the direction of the Lake *Dibbie* of Mr Park, and will not even err very widely in point of distance, considering that the geographical construction on both sides is made up of calculations on very extended *lines of distance*; for the place of the Dibbie Lake rests on its proportion of the distance, reported to Mr Park, between his lowest stations on the *Niger*, and *Tombuctoo*; whilst this latter is placed by the meeting of *lines* of *distance* from *Morocco*, *Tunis* and *Tripoli*;

* The sheep, it appears, travel faster than the goats in that quarter.

but which did not differ much in point of *parallel* from that given by bearings pointed out to him during his route eastward.

On the Map *, then, about 1000 geographical miles may be measured on the curvilinear route across the Desert, between the Encampment in El Ghiblah and the Lake Dibbie, whilst the 106 days at ten, give 1060, or sixty more than the Map. It would be useless to reason on the ground of such *data;* for there seems, from the names and general positions of the Lakes respectively described by Mr Park and Mr Scott, no reason to doubt that they are one and the same. The D is often changed to T, and *Tieb* or *Tee-eb* differs little in root from *Dib-bie.* The 1000 miles give only nine, and somewhat less than a half, instead of ten, for each day.

The Lake, as *described to Mr Park*, is much smaller than the one *seen* by Scott; but no one will regard the two accounts as of equal authority. Mr Park says, (p. 213.) "Concerning the extent of the Lake *Dibbie* (or the *Dark* Lake,) all the information I could obtain was, that in crossing it from west to east, the canoes lose sight of land one whole day." On the other hand, Scott reckons the passage across, twenty-nine hours, at two miles *per* hour. However, it is difficult to conceive how a vessel, capable of conveying 200 persons across so wide an expanse of water, could be rowed or paddled by the same six persons, at the rate of two miles *per* hour! Probably, instead of 58 miles, 43 may be a sufficient number. It may be concluded that they crossed it from the N. W. to S. E., as Mr Park's informant told him, that in going towards Tombuctoo, they navigated it from *west* to *east*, (in effect in the direction of the general course of the Niger,) and consequently in the line of its greatest length; for *river lakes* occupying a portion of the valleys or hollows through which the courses of the rivers lie, have their greatest length in those directions. Scott, therefore, may be supposed to have crossed it in the line of its breadth; and it must consequently be a large lake.

He observed no current in the lake, whilst the vessel lay twice at anchor, but her prow pointed to the eastward, although during calm weather. In a lake of that extent, the current of

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* See the general map of Africa in Mr Park's Travels.

the river would be dispersed, and, therefore, it is difficult to account for the constant position of the vessel. Possibly there might be a light air of wind, but it escaped his notice. There could be no *counter* current in the middle of so wide a lake. With respect to the report of the boatmen on the lake,—if they could have been supposed to possess any proper knowledge of the future course of the Niger, it would have been worth the the attending to. But having the *Shilah* for their vernacular language, they doubtless came from the northern quarter of Africa, and were not likely to have any knowledge of the subject, but from report. The opinion of the North Africans has, in all ages, been in favour of its communication with the Egyptian Nile, which probably arises from an idea that it must necessarily reach the sea *somewhere*. At the same time, it may be remarked, that, in the inland parts of *Barbary*, there are not less than five considerable streams between Morocco and Tunis, which run inland towards the *Sahara*, and forming small lakes on its border, are either evaporated or swallowed up by the sands.

In respect of the quality of the soil in the central part of the Sahara, in the line of the before-mentioned route, it may be observed, that in the maps there are *two tracts* of land in the nature of *islands* or *oases*, or, at least, marked as being different from the sandy tract. They are named *Gualata* and *Taudeny*. It may well be, that these are parts of the tract described by Scott as being free from sand, and although described to be in a position wide of the route, northward, yet either they may be farther to the south, or the direction of Mr Scott's route may have been more northerly. As he set out in June, when the sun's northern declination was very great, he may not have allowed for it sufficiently in his estimation of the eastern and western points of the heavens. The watered valley in which they sojourned so long, falls very near the western part of *Gualata*.

It appears that they returned nearly in the line on which they advanced, until they came near this valley, which was about three-fourths of the whole way. But then they evidently deviated; because they traversed the sandy tract in seven days, which took them eleven in their way out, and also came to a different encampment from the one they had quitted in *El Ghiblah*.

Art. III.—*Remarks on the Currents between the Parallels of Cape Finisterre and the Canary Islands, which may be supposed to have carried the* Montezuma *out of her course.* By Major Rennell, F. R. S., &c. &c. &c.

I should consider myself highly culpable, if I neglected to state, by way of caution to navigators, the result of my inquiries respecting the current which appear to have caused the shipwreck of the *Montezuma*, and of a great number of other ships of our own and other nations, on the western coast of Barbary; having examined a multitude of journals of ships that have sailed in that track, with time-keepers on board, and which have also, when opportunities presented themselves, had their rate checked by celestial observations.

The general result is, that navigators who depart from the parallel of the southern part of the Bay of Biscay, (or say 45°,) and sail in the usual track southward, will be assailed first by a *SE.* current, and then by an *easterly* one, until they have passed the parallel of Cape Finisterre; when the current will again turn to the *south* of *east*, and gradually become a SE. current, till having passed Cape St Vincent, it becomes easterly again; owing no doubt to the indraught of the *Strait* of *Gibraltar*; and this easterly current is pretty general across the mouth of the bay between Cape St Vincent and Cape Cantin.

Beyond this bay (which may be deemed the *funnel*, of which the Strait itself is the *spout*,) the current again becomes *SE.*, or rather more southerly, (as it is more easterly towards Cape Finisterre,) and continues as far as the parallel of 25°, and is moreover felt beyond Madeira westward; that is, at least 130 leagues from the coast of Africa, (beyond which a *SW.* current takes place, owing doubtless to the operation of the north-east trade-wind).

The rate of motion of this current varies very considerably at different times, that is, from twelve to twenty or more miles in twenty-four hours. I consider sixteen as rather below the mean rate. I have one example of 140 miles in eight days, in one of his Majesty's ships; equal to $17\frac{1}{2}$ miles *per* day; and in another of only twelve. And in a very well kept East India ship's Journal, 170 in nine days to Madeira, or nineteen *per* day. The direction of the stream likewise varies, but commonly more towards the *south* than the east, after passing the mouth of the Strait.

Near the coasts of Spain and Portugal, commonly called the Wall, the current is always very much southerly, owing perhaps to the falling in obliquely on the shore, of the great mass of water brought by the SE. current; which can only run off towards the south, and round Cape St Vincent towards the Strait's mouth. And amongst the Canary Islands, and between them and the coast of Barbary, the currents are less regular. I have endeavoured to describe this in the sketch.

It may be taken for granted, that the whole surface of that part of the Atlantic Ocean, from the parallel of 30° to 45° at least, and to 100 or 130 leagues off shore, is in motion towards the mouth of the Strait of Gibraltar.

According to what has been said in the course of the above remarks, it must be expected that a ship sailing in the usual track to Madeira or the Canaries, will be carried to the *south-eastward* at the rate of sixteen miles *per* day; that is, even if she has a fair wind, she will be carried by the current 150 or 160 miles to the south-eastward, in the course of her voyage to Madeira or the Canaries; and, consequently, on a *SE. by S.* course will be carried eighty or ninety to the *eastward* of her intended port. If we suppose a *SE.* course, the error in easting will be no less than 109; which distance, if they were bound to Teneriff, would carry them to *Allegranza* or *Fortaventura*, and if intending to make *Allegranza*, would place them on shore on the coast of *Barbary*. The French and Spaniards report, that their ships have often made *Allegranza* when they supposed themselves on the line towards *Teneriff*. It must be added, that if a ship had a long passage, the error would be greater in proportion, and might possibly amount to 200 miles of *easting*.

It would seem advisable, therefore, that every ship going to the Canaries, or intending to sail between those islands and the mainland of Africa, and being without time-keepers, as that class of merchant ships commonly are, should, to every day's reckoning, *add ten miles of easting*. This would, in the first instance, prevent them from *deceiving themselves* as they went forward; in like manner, as it is better to set a clock forward at once, than to charge one's memory constantly with its being too slow. *Ten miles* does not seem too much as a cautionary measure, as a ship has very lately been carried ninety-nine miles to the *east* in eight days in that track. What would not have been the error had she had even a moderately long passage?

It is this current which has furnished the roving Arabs of the desert with their victims from every nation, and the good Mr Willshire with objects of benevolence.

J. Rennell.

London, 27*th February* 1819.

Art. IV.—*On the Submarine Current at the Strait of Gibraltar, and at the Sound near Elsinore* *.

In our account of Dr Marcet's experiments on Sea-Water, we have noticed the ideas which are at present entertained respecting the existence of a submarine current salter than the ocean, which runs out at the Strait of Gibraltar, and unloads its waters of their excess of salt. Dr Hudson, in the Philosophical Transactions for 1724 †, seems to have first suggested the probability of this submarine current; and there is reason to think that Lieutenant, afterwards Admiral Patton, had the merit of establishing its existence. When this able officer was Lieutenant of the Emerald, he was overtaken with a very heavy

* We have been indebted for the leading facts in this paper to Captain Patton, R. N., the brother of the late Admiral Patton.—D. B.

† See this Journal, vol. II. p. 359. Note.

gale of easterly wind, in approaching the rock of Gibraltar. When night came on, it became necessary to lay the ship to, under a close-reefed main-topsail, to wait for day light and better weather, and this was done as nearly as possible in the mid channel. About one o'clock in the morning, Lieutenant Patton observed an unusual darkness on the lee beam, and supposing it to be land, and the vessel to be in imminent danger, he instantly wore the ship, without waiting even to acquaint the captain. Finding it impossible to clear the land by setting sails, he saw that there was no chance of saving the ship but by trusting to the anchors. One of them was accordingly let go, but before it took effect the vessel struck the ground three times, but the ship, notwithstanding the very high swell, and the breakers within half a cable's length of the stern, rode fast till daybreak, when the weather became more moderate, and the vessel was found to have drove in at the back of the rock of Gibraltar, by a counter current.

In consequence of this narrow escape from shipwreck, Lieutenant Patton was led to study the subject of the currents of the Strait of Gibraltar.

" He had ascertained by experience," says his brother, Captain Patton, " that when two fluids meet in a narrow channel, the one being lighter than the other, that which is heaviest will run out below, at the same rate exactly that the fluid which is lightest runs in above. Of the truth of this, any person may satisfy himself by filling two long phials, one with salt water, and the other with fresh; colour one of them with ink, or any other substance to distinguish it, and place the mouths of the phials close together, holding them horizontally, the salt water, which is heaviest, will be seen to run out below, exactly at the same rate that the fresh water, which is lightest, runs in above. The same law of nature holds with respect to air, which is also a fluid ; if, for example, the air in a room is more heated than the air in the outside, or next apartment, it will of consequence become more rarified and lighter; if the doors be opened between them, and a lighted candle be placed on the floor of the passage of the door, the flame will blow inward with the cold air running in below; but if the candle is held up near the upper part of the door, the flame will go outward with the warm and light air blowing out as fast above as the heavy air comes in below.

"Lieutenant Patton, therefore, very naturally conceived, that if the water within the Mediterranean be heavier than the water in the Atlantic, the water of the latter, according to the laws of gravity and fluids, must of course run in above, and at the same rate the water of the Mediterranean, being heaviest, run out below; and in this particular case, as the cause must be perpetual, the effect must follow; and the upper or surface-current never cease to run in from the Atlantic to the Mediterranean.

"In order to ascertain the fact, whether the water in the Mediterranean is actually heavier than the water in the Atlantic, Lieutenant Patton filled some bottles of sea-water, at a distance from all land, in the Atlantic, and also some bottles near the middle of the Mediterranean, which were afterwards carefully and accurately weighed; when a flask, containing one pound six ounces and five drachms of the Atlantic water was found to be thirteen grains lighter than the same flask, most exactly filled with an equal quantity of the Mediterranean water.

The difference of weight seems small in the contents of a flask, but, on so large a body of water as the Gut of Gibraltar must contain, is quite sufficient to account for the constant current which, from this cause, as Lieutenant Patton has fully ascertained, runs from the Atlantic into the Mediterranean."

A submarine current, similar to that of the Straits of Gibraltar, has been observed by the present Captain Patton, R. N. The ship which he commanded having had occasion to anchor some miles from Elsinore, he found a current running from the Baltic, at the rate of *four* miles an hour by the log. Upon dropping the lead, in order to ascertain the depth of water, which was about *fourteen* fathoms, he found the line continue perpendicular from his hand, when the lead itself was raised a little from the ground. Hence he concluded, that an under-current, equally rapid with that on the surface, had prevented the lead and line from yielding to the opposite motion of the fluid, as it would have done had the ship been sailing at that rate through the water. The Baltic consists of brackish water, and the currents in the Sound frequently change by the influence of the winds.

Art. V.—*Observation on the Mineralogy of Halkin Mountain, in Flintshire; with a particular account of the recently discovered Buhrstone and Porcelain-Clay of that place.* By Thomas Stewart Traill, M. D. F. R. S. E. M. G. S., &c. In a Communication to Professor Jameson.

The elevation known under the name of Halkin Mountain, is one of a range of hills, stretching from Holywell towards Mold, and has been long celebrated for the richness of its mineral veins. From these a prodigious mass of lead-ore has been extracted; and there are at present extensive mines wrought in different parts of this ridge: but its mineral wealth, within the last three or four years, has received an important addition from the discovery of a curious siliceous rock, admirably adapted to supply the place of the best French Buhrstone in our flour mills; and of a bed of beautiful white Clay, which is now successfully employed in the Staffordshire Potteries. To render the account of these interesting substances more complete, I shall commence with a brief survey of the geological features of this part of North Wales.

The district of Flintshire bordering on the estuary of the Dee, may be considered, in a general point of view, as formed of three nearly parallel ranges of hills, with the intervening valleys. The range which skirts the river is low, undulating, and, after some miles, sinks into a plain of considerable extent. The surface in this first portion of the district is covered by a fertile soil, presenting a beautiful intermixture of woods and cultivated fields. The soil rests on an extensive coal formation, in which the beds are clay, shale, sandstone-flag, and coal; which last alternates with the other substances in twelve distinct beds of various thickness. The most ancient coal-mines in this formation are near Mostyn-Hall; and some of them have been wrought since the time of Edward I. The mines have the depth of from 100 to 135 yards. In the principal mine at present wrought, the first coal-bed occurs at the depth of 33 yards, and is covered by clay, shale, and a thin sandstone-flag containing much mica. The different beds of coal vary from 1 foot to 9 feet, and even 15 feet in thickness, and their general inclination is estimated at one yard in three; varying from one in four to two in three yards. The general dip is towards the E. S. E.

The Flintshire coal-beds extend in length from *Llan-Asa*, through the parishes of Whiteford, Holywell, Flint, Northop, and Hawarden; a distance, in a direct line, of about twenty miles *. Their breadth is limited, on the one hand, by the valley between the first and second ranges of hills, and on the other by the Dee. There can, however, be little doubt, that the Neston Collieries, on the opposite Cheshire shore, are part of the same coal-field. The Neston mines, indeed, extend nearly two miles under the bed of the river, in a direction towards Flint. Through this extent the coal beds are not to be considered as uninterrupted. They are subject to great irregularities from shifts and dislocations of the neighbouring strata, which in some places are so striking, that the coal-beds may be considered as included in a series of detached basins, of greater or less extent. An intelligent friend, practically acquainted with the coal-fields of this district, informs me, that near Northop, he has seen an instance of the coal-formation extending to the *west* of the valley, between the first and second range of hills; and the same is said to occur near Holywell. The cause, however, which gave the channel of the river its present form, seems to have produced a dislocation of the coal-beds; for the dip at Neston is said to be towards Wales, while that of the Flintshire mines is toward the opposite point of Cheshire. The coal of Flintshire is of various qualities. Some of the beds yield a coal in some measure resembling the *candle-coal* of Lancashire; but most of it rather inferior to the best Wigan coal. Much of what I saw at Mostyn Coal-works was contaminated by pyrites. In this colliery, the main shaft at present only extends through nine beds; the last of which is more than two yards in thickness, and rests on a bed of yellowish-grey shale, with a greasy lustre, in the numerous cracks which traverse it in all directions. This shale, which is three feet in thickness, is much prized for making and *setting* of fire-bricks †. The refuse of some of the

* The coal-fields which contain the great beds of ironstone smelted between Llangollen and Wrexham, in Denbighshire, are a continuation of the same coal-formation.

† There are three other coal-beds below this shale, each from 3 feet to 3 feet 9 inches in thickness but a tremendous explosion of fire-damp, which took place

old coal-works, by spontaneous decomposition, has been converted into a blackish clay, containing a small portion of sulphate of argil, and more sulphate of iron. Not far to the south of Mostyn-Hall, by the shore, is a singular cliff, composed of large masses of perfect slags, cementing fragments of semi-vitrified and indurated sandstone flag. Large blocks of this *pseudo-volcanic* substance are scattered on the beach, and present a brilliant contrast of colour, from bright fiery-red and orange-yellow, to pale lilac and dark iron-brown. These substances occur in two parts of the cliff. The most southern portion extends about 20 yards in length. This is separated from the second by low cliffs of sandstone flag, about 110 yards long. The second, containing the most perfect vitrifications and scoria, extends about 25 yards. The whole cliff is from 30 to 50 feet high. The marks of fire in some places are only visible by the red colour and hardness of the shattered rock, while in others, the fused matter has interlaced itself with the broken stone. The most perfect slags are detached masses, some of which are six or seven tons in weight. The whole is the product of an accidental fire in a coal-work, extensive traces of which are still apparent above the cliff.

The second range of hills may be said to extend from the parish of Llan-Asa, in an irregular ridge, occasionally intersected by dells, to the vicinity of Mold, where it approaches the third range, Mostyn Mountains, conspicuous by its ancient Pharos. The hills around Holywell, the Halkin and Bulkeley Mountains, are included in this range. The name of *Hill* is much more applicable to these than the appellation of Mountain. Their slopes, and sometimes their summits, are cultivated and adorned with neat cottages and gentlemens' seats. This range is separated by deep valleys from the lower range. Its general structure seems to consist of beds of limestone, containing marine remains, which are in many places covered by thick irregular beds of a siliceous slate, in some places passing almost into hornstone; in other situations into a rock intermediate betwen flinty-slate and clay-slate; and this last, in the hills above

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in these lower beds some years ago, suspended the works, and these seams have not since been attempted.

Holywell, graduates, as it approaches the surface, into perfect shale. From the dip of this limestone formation to the east, it would appear to pass below the coal-*measures* of the lower range. Both the siliceous slate, and the limestone, abound in rich veins of lead-ore and calamine. The two substances are often found together The calamine is most abundant a little to the north of Holywell, on the roads of St Asaph and Whiteford. This mineral was here so little known about a century ago, that the finest ores were employed as a material for repairing the highways; but when its value was discovered, the roads were broken up, and limestone, or siliceous rock, substituted for the more valuable material.

Some years ago I remarked an abundance of fine reniform or botryoidal calamine in the mines round Holywell, and found crystals of the same substance in many specimens. On a late visit I was unsuccessful in procuring either, the ore principally consisting of a much corroded calamine, in the state of oxide, of a dull yellowish-grey colour, sometimes varied with pale yellow, green, orange, and bluish tints, of great hardness, and considerable specific gravity. This ore usually accompanies galena. The lead-ore of this district is chiefly galena, but considerable quantities of green phosphate are occasionally found. I have specimens in prismatic crystals, but it is usually amorphous. I am in possession of a mass of green phosphate of lead, nearly pure, which weighs upwards of twenty pounds avoirdupois. I have also lately received specimens of rich indurated white-lead-ore from Bruen-mine near Holywell. Mixed with the lead and calamine, there is found much common brown blende, or sulphuret of zinc. The mineral veins in this district have a direction north and south, and also east and west. The latter, at least in the superficial veins, are considered as the most productive, but some of the richest veins on Halkin run north and south. The calamine is converted into brass ingots, plates, and wire, by mills, on Holywell stream. The lead is smelted in numerous furnaces, erected near the shores of the Dee, and the quality of the metal obtained is reckoned excellent. The quantity of silver in the Flintshire galena will not in general repay the cost of *parting;* but the rich argentiferous galena of Cardiganshire is assayed for silver at the extensive works of Mr

Roskell, near the town of Flint. There are copper-works along the coast, but they are not supplied by the mines of this country. No considerable body of copper has yet been discovered in Flintshire; but the produce of the mines of Anglesey and other parts of Wales, are here converted into bars, wire and sheets, both for *boilers* and *sheathing*, by means of machinery wrought by the copious stream which bursts out from the sainted spring of Winifred, and gives a name to the romantic and busy town of Holywell. I may here remark, that this celebrated spring diminishes one-third, or even more, in great drought; and though usually limpid, I have seen its waters of a muddy whey-colour after heavy rain. Its temperature is considerably above that of the medium temperature of the climate, and it appears to vary at different times. In 1820, when muddy, I found it 57° Fahr.; several years ago it was as high as 59°, but it is said usually to be 58°. These variations are remarkable in a spring which pours out in its usual state twenty-one tons of water *per* minute. It is remarkable also, that most of the European thermal springs occur in limestone countries.

The third range of hills is the lofty ridge which, under different names, forms the eastern boundary of the fertile vale of *Cwyd.* On the slopes towards the Dee, it consists of a hard and pretty compact limestone, in tracing which, from Diserth to Caergwrle and Llangollen, many years ago, I found the limestone to contain encrinites and other corallites, and it appeared to rest on highly inclined strata of an argillaceous-slate, which constitutes a large portion of North Wales, and would be considered by the Wernerian geologists, as belonging to rocks of Transition. The limestone, which rises into a lofty mountain just above Diserth, appeared to me to have the characters of what is called the oldest flœtz-limestone, abounding in galena and calamine, which, near Mold, are accompanied by compact and earthy sulphates of barytes, as vein-stones.

Such is the general distribution of the mineral products of this part of North Wales. We shall now examine more particularly *Halkin-Mountain,* long celebrated for its lead-mines, and now become additionally interesting by the discovery of the valuable buhr-stone, and the fine porcelain-earth above noticed; premising that the lead-mines of this place are either wrought by Earl Grosvenor, the lord of the soil, or by small parties of operative miners, who unite in taking short leases from his Lordship; that the right of extracting the buhrstone and porcelain-clay is leased by a company of gentlemen, who were the discoverers of their value, and that the operations for obtaining the two last, are directed by one of the partners Mr Bishop, to whose politeness the curious visitor will find himself much indebted.

The ascent of Halkin from *Pistill*, the hospitable residence of Mr Bishop, is steep. After passing through some inclosures, we enter on a mineral tract, which has been excavated by innumerable shafts in all directions. These all seem to have been of inconsiderable extent; and having been carried on by unconnected parties of a few poor adventurers, had been injudiciously wrought at a vast expence of ill directed labour. Some idea of the attempts which have been here made, may be collected from the fact, that on an angle of the common, just above the *Milcor-mine*, in an area of about three acres, I counted the vestiges of between two and three hundred diminutive shafts, or other mining excavations. The average depth of these, according to an intelligent miner whom we met on the spot, seldom exceeds from ten to seventeen yards, though a few penetrate to the depth of thirty or forty. Some of these pits are wrought by parties of three or four miners. Their apparatus, beside the pick-axe and shovel, assisted by blasting, consists of a rude wince, turned by the hand placed over the shaft, for raising the ore and rubbish. The poverty of the adventurers generally renders other apparatus unattainable, and a small quantity of water usually puts an end to the work. Though numbers fail in obtaining more than a scanty subsistence in this lottery, the occasional instances of successful adventure encourage many labourers to speculate in the mines. The Milcor-mine was carried on in a different manner. It is almost half way up Halkin, near the road to Northop. The shaft had a large steam-engine on it, which drew water from the depth of 144 yards. According to the miners, the first fifteen yards penetrate through soil, alluvial matter, and crumbling shale; then succeed forty yards of a slaty rock resembling shale, but, gradually hardening as we descend, it becomes siliceous-slate, and is succeeded by thick beds of the same substance, (here named *Chert* or *Chirk* by the miners,) which continues to the depth of eighty-five yards more. The principal lead-veins in this mine are in the *chert,* and the shaft has only been sunk four yards in the limestone. The whole beds here generally dip *one* in *three,* but this is subject to considerable variation. This mine may be considered as unfolding the geological structure of the eastern side of the mountain; for it nearly corresponds with what has been observed along all this slope. As we ascend, however, the slaty-rock decreases in thickness, or gives place sooner to the solid beds of *chert,* and almost disappears on the summit. The shafts of two extensive mines on the summit are wrought by Lord Grosvenor, and go to great depths. The *Old-Rake* mine near Halkin Hall has reached the depth of eight score yards. It has no steam-engine on it; the ore is raised by well constructed horse-engines, and his Lordship's engineers are now engaged in carrying a new level toward it from the lower part of the adjacent valley. This level commences at Nant-y-Flint: about 500 yards in length are already excavated, but when completed, it will extend about 1500 yards farther, and, at this point, will be 230 yards below the surface on the eastern slope of Halkin. The work is carried on day and night, yet it will still require several years for its completion: its estimated cost is said to be L. 20,000. I may here remark, that some of the mines near Holywell are drained by a well constructed and judicious level, begun in 1774, and carried into the mountain for about 1200 yards. The Old-rake has been a most productive mine, and is still wrought with spirit. The other mine, called Lord Grosvenor's *Main,* on the southern summit of Halkin, has also a deep shaft. The ore is here drawn up by a new double-stroke steam-engine, and the mine is pumped by a large Watt's atmospheric engine. The depth of the shaft is nine score yards, and the effect of the general rise of the beds of Halkin mountain towards the west, is here apparent in the nearer approximation of the limestone to the surface. The first sixty yards are through the slaty rock and *chert,* but the rest of the shaft is driven through beds of a bluish-grey limestone. In this mine the principal metallic veins run east and west, but in the *Old-rake* they lie north and south, which last have been extremely rich, contrary to the prevailing opinion among the miners of this district, who are said, in some instances, to have carried their prejudices against north and south veins so far, as to have abandoned promising veins in this direction, on meeting with a trifling shift, the removal of which afterwards enriched more enterprising adventurers. Indeed, one is tempted, from the accounts given by the miners, to imagine, that the richest veins in the chert of this place run east and west, while the most profitable veins in the limestone lie in a north and south *direction*. There is another considerable mine on the north-west summit of Halkin, called *Gelly-Fowler-Fields*, which for some time yielded much green phosphate of lead; but this ore has lately become scarcer, and the galena has become more abundant. The large mass of green phosphate above mentioned was found in this mine; but this ore occurs both massive and crystallized in other parts of this mouutain.

Halkin is much less steep on its western than its eastern side. On the former it gradually slopes into a wide cultivated valley, which extends to the third range of Flintshire hills. Its general direction is NNW. and SSE., extending between three and four miles in length, with a medial breadth of less than a mile. Its top is undulated, presenting a considerable extent of irregular plain, sterile, and in many places rocky. The limestone has already been sufficiently described, but the slaty rock and chert require a more particular detail. The upper rock on some parts of the mountain cannot be easily distinguished from common shale, crumbling down on exposure to the air, into small angular fragments, which, by farther decomposition, are resolved into clay. Below this lies a slaty rock, often veined and clouded with various shades of grey; its lower strata become harder, and it passes gradually into a true siliceous-slate. This rock, in the state intermediate between shale and siliceous-slate, occurs in large quantity in the hill just above Holywell, where it is much used for building. It is usually prettily veined with parallel lines of dark and light grey colours; it is tolerably hard, but may be easily scratched with a knife; its specific gravity I found to be 2.4885. Its stratification becomes less and less distinctly visible, as we trace it downward; its hardness and density increases, its fracture inclines to splintery, and it finally passes into the *chert*, which appears to me to be a pure siliceous slate. Near the *Old-rake* a weathered variety of this slaty rock occurs on the surface, beautifully veined and clouded with reddish-brown and ochre-yellow, on a light yellowish-grey ground; but the more usual colour-delineations are blackish-grey, streaked with fine parallel lines of a smoke-grey colour.

The rock called by the miners *chert*, is a massive siliceous slate, not disposed to divide into thin layers, but occurring in thick beds. Its colour is bluish-grey, mixed with yellowish-grey. Its fracture is splintery, sometimes passing into imperfectly flat conchoidal, with a very feeble lustre on the latter surfaces; but is dull where splintery. Its edges, in the purest specimens (as in that of Mr Bishop's quarry), are highly translucent. It is often traversed by many small veins of quartz; but large blocks, of great purity and uniform structure, may be procured in some places, especially in the above-mentioned quarry, which is in a rocky crest on the eastern ridge of the mountain. The specific gravity of this sort is 2.6363. The blocks here raised are brought to Flint, and there shipped at the rate of L. 1 : 2 : 6 per ton, for the potteries in our midland counties, where they are employed to grind flints for the better sort of porcelain. The purity of this rock augments the product of fine siliceous earth, by its own attrition during the process. The rock of this quarry, it may be remarked, bears a striking similarity to the siliceous substance found, in small quantity, resting on the massive limestone of Windmill-hill at Gibraltar, which appears to me also a siliceous slate *. The rock of the above quarry is known to our potters by the name of *Blue Chert*, to distinguish it from another kind, of a whiter colour, which Mr Bishop procures from a quarry on the southern part of Halkin, and sells to the manufacturers of the finer sort of china-ware, at a somewhat higher price. This *white chert* seems to be the transition of siliceous slate into quartz; or rather a species of quartz-farcilite, with translucent nodules. The white chert of Mr Bishop's quarry is now used not only for grinding flints, but as common millstone. It is in great request, and is shipped at L. 1, 5s. per ton.

* It is the "flint of a sap-green colour" of Colonel Imrie.—See his valuable paper in *Edin. Phil. Trans.* vol. vi. p. 3.

Near Lord Grosvenor's *Main*, there is another variety of the siliceous rock, with a multitude of minute pores, which is exceedingly hard and tough, and is by some intelligent persons thought to be well adapted for grinding barley. It might be pierced and framed for this purpose, like buhrs; but none of such millstones have yet been manufactured.

About half a mile from Lord Grosvenor's main, lies the quarry of a still more valuable variety of the *chert*, the substitute for the buhrstone of France. This substance seems the transition of the siliceous slate into a hornstone, rendered porous chiefly by containing siliceous petrifactions of different species of corals. A thin covering of soil here rests on debris of siliceous slate; under this occurs a bed of siliceous rock, four feet in thickness. This bed is generally dense and compact; but its lowest part becomes porous, both from its structure and abundance of corallites. A second bed contains the finest buhrs. Large masses of this stone may be procured, exceedingly hard, extremely porous, and very uniform in their quality. This sort of rock passes, in some parts of the quarry, into the compact *chert*; but there is at this spot a large body of the vesicular rock, admirably adapted for millstones of the best quality. Masses of it, from half a ton to upwards of two tons, may be procured of very uniform quality. Its general colours are greyish-white, and various shades of light grey. It is full of pores, which are partly owing to the abundance of petrifactions it contains, and in part to the vesicular texture of the rock itself. From the number of its vesicles, the fracture is not always easily detected; but it is decidedly splintery in the more solid parts. It is hard, and is broken with great difficulty. The edges are translucent. The specific gravity of fragments of a medium quality is 2.5022.

The equal distribution of the pores in large masses of this rock, and its extreme hardness, induced the discoverers, who had experienced its efficacy in grinding flints for the potteries, to try it as a millstone; and experience has justified their most sanguine expectations. When wrought up like French buhr, it has been found to equal the best foreign millstones. I saw a pair, five feet in diameter, in the water flour-mill at Flint. They had been nearly three years in use, and, according to the miller's testimony, proved as *sharp* and *tough*, as the best

French buhrs used in his mill. Another pair have been at work four years in a flour-mill within a few miles of Holywell, and are reckoned equal to the foreign millstones. At *Dunham-o'-the-Hill*, between Chester and Frodsham, a curious experiment has decided the value of this rock. A pair of millstones were constructed, with alternate pieces of the French and Halkin buhr. These have been in use about four years, and continue to give as perfect satisfaction as if the whole had been constructed of foreign stone *.

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* The following documents are copies of letters which the proprietors have received from several intelligent millers of experience:

" GENTLEMEN,

" I have given the Flint buhr mill-stones a very fair trial, and you may send buhrs for another pair as soon as convenient. I have great pleasure in saying they answer remarkably well, in some instances better than the French mill-stones, particularly in respect to cone wheat; and in other kinds of wheat, they are not inferior to the French. I have now at work twenty-two pair of mill-stones, some from Whittle Hills, some from Mow Cop, some from Beestone, some from Anglesea, several from France, and one pair from your quarry, and your FLINT BUHRS are, in my opinion, superior to any of them, in respect to the flour of wheat. I have tried a Flint buhr-bedstone, with an Anglesea runner, and the grinding was much inferior than at present, as both of the stones are of the Flint Buhrs.

" If you or your friends wish any further information on the subject, I will most willingly reply to any inquires, or the stones may be seen here at work at any time. I am, &c. JOHN DUMBELL.

" *Mersey Mills, Warrington, 24th Oct.* 1820.

" To the Welch Company."

" GENTLEMEN,

Inclosed I hand you a draught for a Flint buhr-millstone I received several months back on trial. I suppose you thought me long in making up my mind; but to give a just report requires a deal of time, and indeed is a serious matter, as millstones well made will last for many years. However, I have to say it has been applied several weeks in grinding wheat: it grinds equal to French stones, and better than some of them; but I had it to grind barley, peas, beans, &c. and, as such, it is now working. I can say it answers better than ever I met with one before, from an experience of more than thirty years. The face and dress keep good, and for a great length of time. I intend in the spring to have a pair 4 feet 8 inches to grind wheat. I am, &c. JNO. PRATT.

" *Saredon Mill, near Walsal, Staffordshire.*

" To the Welch Company."

" GENTLEMEN,

" It is with the greatest pleasure I give you leave to say, that I wished to try a buhr of your Flint quarry, and as you were so good as to give me one, I caused it

Millstones of the Flintshire buhrs, manufactured by Messrs Bishop and Company at *Nant-y-Moch*, near Holywell, or by their agent John Coleman of Liverpool, have been recently sent to different parts of Lancashire, to Leeds, Dublin, &c.; and there is every reason to believe, that the quarries of Halkin will render Britain independent of foreign countries for the supply of this very essential article. By the following statement of prices, it appears, that the Halkin buhr-millstones may be had at about one-half the cost of the French millstones used in this country:

	Feet.	In.					
A pair of	4	0	millstones complete,	£24	0	0	Thickness, of *Runners*, 8 inches. of *Bedstones*, 6 inches.
Ditto,	4	6	ditto, -	32	0	0	
Ditto,	4	8	ditto, -	35	0	0	
Ditto,	4	10	ditto, -	38	0	0	
Ditto,	5	0	ditto, -	42	0	0	
Ditto,	5	6	ditto, -	52	0	0	

These buhrs are shipped at £6, 6s. *per* ton. They may be had from 50 lb. to several hundred weight each. The French buhrs average about forty to each ton.

On the western side of Halkin mountain, about half a mile N. NW. of the buhr-quarry, lies the bed of Porcelain-clay. On two sides of the clay-pit, I found at the surface limestone of a light-grey colour, containing many large bivalve petrifactions, which were also calcareous. This limestone presented a mural surface a few feet high towards the clay, which seems to occupy a considerable hollow in the beds of limestone. I did not discover the junction of the siliceous rock with this limestone; but the colour of the latter, the nature of its petrifactions, and its little inclination, render it doubtful whether this should be considered as the same limestone which lies under the *chert* on the

to be fixed in with the best French buhrs some months ago, and, as far as we can judge in such cases, I think they will answer every purpose of French buhrs. Yours respectfully, JOSEPH STEPHENS.

"*Steam Mill, Harrington, Liverpool.*

"To the Welch Company."

other side of Halkin. I am disposed to consider it of a distinct series of beds. The clay-pit presents a remarkable appearance. It occupies a basin apparently in the limestone. Just below the soil, lies a coarse clay, coloured by iron, and in some places by carbonaceous matter. It is friable, from being much mixed with sand. The colouring matters are unequally distributed, giving a variety of red and yellow tints. The carbonaceous portions are blackish-grey, but they burn white in the fire. They have been used as an oil-paint. Under this lies a thick bed of very white quartzy sand, slightly cohering while wet, from containing a little white clay. This sand, when washed, seems well adapted for the glass-house, or might be used instead of flint-powder in porcelain manufactories. In some places, this sand is richly variegated with bright red and yellow hues, from nests of coloured clay, the yellow portions of which have most of the qualities of *variegated clay*. The bed of sand becomes more fine as it descends, and, at the depth of two or three yards, passes into a pure white clay, which we shall now describe.

The great mass of this clay, when dried, has the following characters. It is either snow-white, or has the faintest tinge of greyish-white. Its particles are dull and dusty, soiling strongly. When rubbed between the fingers, the fineness of its particles prevents harshness, and it is rather soft, though not greasy to the touch. This is the general character; but some masses disseminated through the bed, and especially in the lowest point yet reached, have rather a greasy feel, and, when rubbed, become shining on the surface, as if passing into lithomarge of the purest white colour. The clay adheres a little to the tongue. Its specific gravity is 2.4385.

When either the dull or the greasy-looking clay is thrown into cold water, it rapidly gives out air, with a hissing sound, and falls into powder; the greasy sort rather less rapidly than the other: but both are inclined to form a paste with water. In some experiments which I made, specimens of the clay yielded more than 80 *per cent.* of silica; the rest was alumina, and a most minute trace of iron; but as I afterwards discovered that the subject of my experiments had been diffused through water, and again dried, after it was taken from the pit, it is my intention to repeat the analysis on the clay in its native state. The clay is known in commerce by the name of *Cambria.*

It forms a thick bed, the extent and exact depth of which has not been ascertained. It is found in several adjacent mines. In a shaft one mile west of the present clay-pit, it occurs twenty yards below the surface; as also in another mine a quarter of a mile south of the pit; and it may possibly be discovered in other parts of this district. No attempt has been made, by boring through the bed, to ascertain the depth of this clay; but Mr Bishop having sunk a shaft about twenty-six yards E. SE. of the deepest part of the pit, found different layers of coloured clay, and also this pure white clay, almost to the depth of sixty yards from the surface. At this depth, the workmen came to limestone. From this shaft, in which there are indications of lead-ore, a level is driving for draining the pit, by bringing its waters in contact with the rock, which is full of rents, and has sufficient *fall* for this purpose. When this operation is completed, we shall ascertain the depth of the white clay, which appears to constitute a very thick unequal bed. The clay appears to be purer the deeper it has been yet explored. In some places it is contaminated by nests of bright yellow clays; but the great mass of it is pure white. Among the white sand, and also in the clay, is found a greyish-white crumbling stone, with a slaty structure, which seems a transition of siliceous-slate into this clay; holding the same relation to them that shale does to common clay and clay-slate. From its appearance, it might be supposed a siliceous slate, heated to redness, and then plunged into water. Its constituent parts are the same as the ingredients of the clay; and it is now in great request with the potters, under the name of *Rock Cambria.* The occurrence of this substance with the sand and clay, would lead us to consider the two latter either as arising from the decomposition of siliceous slate, or as the materials of that rock arrested, by some unknown cause, in their consolidation, ere the cohesion of their particles had united them into a homogeneous mass. It is shipped for 12s. 6d. *per* ton, and is now employed in the potteries as an excellent substitute for Gravesend flints.

The clay is dug out of an open pit; and, after being diffused through water, to free it from any intermixture of gritty sand, is dried and sold at Flint for £3, 12s. *per* ton. It is now greatly prized by our potters, for the beautiful quality of the ware produced, by mixing with plastic clays, containing more alumina. By itself, it evidently has too much silica to form a perfect *biscuit.* When the attempt is made, it produces one of a dazzling whiteness; but this may be scraped with a knife, and *flies* when glazing is attempted. If, however, *cambria* be mixed in due proportion with common potters-clay, it forms a *stoneware* of superior colour even to our finest Worcestershire china, and infinitely more beautiful than the best stoneware heretofore made at the Staffordshire potteries. The following comparative statement of the expence of the materials commonly used for the best *blue printed stoneware,* and of the mixture of cambria employed for the same purpose, as all the ingredients now cost in Staffordshire, may be interesting. Washed cambria is shipped at 72s. *per* ton, with carriage, &c. 14s. 6d. = £4 : 6 : 6 *per* ton :

No. 1.
Cambria mixture or Body.

	£	s.	d.
40 cwt. Cambria *, -	£8	13	0
20 cwt. Blue Clay, -	2	5	0
$5\frac{3}{4}$ cwt. Powdered Flint,	1	14	0
1 cwt. Cornish Stone †,	0	5	0
$66\frac{3}{4}$ cwt.	£12	17	0

Or £3, 16s. *per* Ton.

No. 2.
Common Body.

	£	s.	d.
1 cwt. Flint, -	£0	5	0
3 cwt. Blue Clay, -	0	6	9
1 cwt. Cornish Clay,	0	6	0
5 cwt.	£0	17	9

Or £3, 11, *per* Ton.

Each ton of the common body is calculated to afford 300 dozen plates, weighing rather more than 8 lb. *per* dozen. If we suppose that a ton of the cambria mixture will yield as many plates, they will be rather less than one farthing *per* dozen dearer than the common blue ware; while they even surpass China in beauty of colour, and, from the smoothness of surface, may be neatly ornamented with painting and gilding. In some manufactories, the following mixtures are employed:

* When so large a proportion of *cambria* is used, the ware requires a felspar glaze; but the common lead-glaze may be employed when there is a larger proportion of plastic clay than one-half of the whole mixture.

† This is a disintegrated granite, containing some mica, which impairs the colour of the *biscuit.*

No. 3.	No. 4.
Cambria Mixture.	Common Mixture.
1½ Cambria.	4 parts Blue Clay.
4 Blue Clay.	1½ Cornish Clay.
1 Rock Cambria.	1 Flint.

The proportions in the two last mixtures are said to produce a great improvement in the appearance of the ware; and though the Cambria mixture No. 3. still maintains its superiority, it costs less than the common mixture No. 4.

The fine Halkin clay has also been used in the manufacture of the finer sorts of porcelain, for which it seems well adapted, by its purity and whiteness. The proportions in which it enters into porcelain, I am unable to state, because each manufacturer keeps the relative proportions of the constituents of his china a profound secret. There can be little doubt, that the employment of this substance will improve the appearance of our porcelain; and, when its qualities are sufficiently investigated, it promises to diminish the cost of production; for the particles of the clay, already reduced almost to an impalpable powder, will require but little further comminution, to render it immediately applicable to the purposes of art.

There may be some difficulty in designating this clay, according to a received mineralogical nomenclature. Notwithstanding the great difference in the proportion of its ingredients and those of the porcelain-clay of our systems, it should, I think, be considered merely as a variety of this substance, which can only be reckoned a mechanical mixture, and therefore may admit of considerable differences in the proportion of its constituents.

The discovery of this clay and of the buhrstone, induced me, when lately in that vicinity, to revisit Halkin; and I submit this sketch, the result of a short examination of the mountain, —trusting that the imperfections of the paper may find some palliation, in my desire to diffuse the knowledge of discoveries so important to my countrymen.

LIVERPOOL,
25th Dec. 1820.

Art. VI.—*On Isothermal Lines, and the Distribution of Heat over the Globe.* By Baron Alexander de Humboldt. (Continued from Vol. IV. p. 37.)

All the ratios of temperature which we have hitherto fixed, belong to that part of the lower strata of the atmosphere which rests on the solid surface of the globe in the northern hemisphere. It now remains for us to discuss the *temperature of the southern hemisphere.* In few parts of natural philosophy, have naturalists differed so widely in opinion. From the beginning of the 16th century, and the first navigations round Cape Horn, an idea prevailed in Europe, that the southern was considerably colder than the northern hemisphere. Mairan and Buffon * combated this opinion by inaccurate reasonings of a theoretical nature. Æpinus † established it anew. The discoveries of Cook made known the vast extent of ice round the South Pole; but the inequality in the temperature of the two hemispheres was then exaggerated. Le Gentil, and particularly Kirwan ‡, had the merit of having first demonstrated, that the influence of the circumpolar ice extended much less into the temperate zone than was generally admitted. The less distance of the sun from the winter solstice, and his long continuance in the northern signs, act in an opposite manner || on the heat in the two hemispheres; and as (after the theorem of Lambert) the quantity of light which a planet receives from the sun, increases in proportion to the true anomaly, the inequality in the temperature of the two hemispheres is not the effect of unequal radiation. The southern hemisphere receives the same quantity of light; but the accumulation of heat in it is less §, on account of the emission of the radiant heat which takes place during a long winter. This hemisphere being also in a great measure covered with

* *Theorie de la Terre*, tom. i. p. 312.—*Mémoires de l'Acad.* 1765, p. 174.

† *De Distributione Caloris*, 1761.

‡ *Estimate*, &c. p. 60.—*Irish Trans.* vol. viii. p. 423.—Le Gentil, *Voyage dans l'Inde*, vol. i. p. 73.

|| Mairan, *Mem. Acad.* 1765, p. 166.—Lambert, *Pyrometrie*, p. 310.

Prevost, *De la Chaleur Rayonnante*, 1809, p. 329. & 367. § 280,—306.

water, the pyramidal extremities of the continents have there an irregular climate. Summers of a very low temperature are succeeded, as far as 50° of south latitude, by winters far from rigorous. The vegetable forms also of the torrid zone, the arborescent ferns, and the orchideous parasites, advance towards 38° and 42° of S. Latitude. The small quantity of land * in the southern hemispheres, contributes not only to equalise the seasons, but also to diminish absolutely the annual temperature of that part of the globe. This cause is, I think, much more active than that of the small eccentricity of the earth's orbit. The continents during summer radiate more heat than the seas, and the ascending current which carries the air of the equinoctial and temperate zones towards the circumpolar regions, acts less in the southern than in the northern hemisphere. That cap of ice which surrounds the pole to the 71st and 68th degree of south latitude, advances more towards the equator, whenever it meets a free sea; that is, wherever the pyramidal extremities of the great continents are not opposite to it. There is reason to believe, that this want of dry land would produce an effect still more sensible, if the division of the continents was as unequal in the equinoctial as in the temperate zones †.

Theory and experience prove, that the difference of temperature between the two hemispheres, cannot be great near the limit which separates them ‡. Le Gentil had already observed, that the climate of Pondicherry is not warmer than that of Madagascar at the Bay of Antongel in 12° of S. Lat. Under the parallels of 20 the Isle of France has the same annual temperature, viz. 80°.1, as Jamaica and St Domingo. The Indian Sea between the east coasts of Africa, the Isles of Sonde and New Holland, form a kind of gulf which is shut up to the north by Arabia and Hindostan. The isothermal lines there appear to go back to the South Pole; for farther to the west in the open sea between Africa and the New World, the cold of the southern hemisphere already causes itself to be felt from the 22d degree, on account of its insulated mountains and particular loca-

* The dry lands in the two hemispheres are in the ratio of 3 to 1.

† The dry lands between the tropics, are in the two hemispheres as 5 to 4, and without the tropics as 13 to 1.

‡ Prevost, p. 343.

lities. I shall not mention the island of St Helena, Lat. 15° 55′ whose mean temperature, according to the observations of M. Beatson, at the sea side, does not exceed 71°6 or 73°4. It is the eastern coast of America, which, in the observations of a Portuguese astronomer, M. Benito Sanchez Dorta *, present us with the S. Lat. of 22° 54′, almost at the limit of the equinoctial region with a plan, of which we know the climate by more than 3500 thermometrical and barometrical observations made every year, to ascertain the horary variations in the heat and pressure of the air. The mean temperature of Rio Janeiro is only 74°.3, whilst, notwithstanding the north winds which bring the cold air of Canada during winter into the Gulf of Mexico, the mean temperatures of Vera Cruz, (Lat. 19° 11′,) and of the Havannah, (Lat. 23° 10′,) are 77°.9. The differences of the two hemispheres become more sensible in the warmest months.

Rio Janeiro.	Mean Temp.	Havannah.	Mean Temp.
June,	68°.0	December,	71°.8
July,	70 2	January,	70 2
January,	79 2	July,	83 3
February,	80 6	August,	83 8

The great equality in the division of the annual heat in 34° of N. and S. Lat. is very surprising. If we attend to the three continents of New Holland, Africa and America, we shall find, that the mean temperature of Port Jackson, (Lat. 33° 51′,) is, after the observations of MM. Hunter, Peron, and Freycinet, - - - 66°.7
That of the Cape of Good Hope, (Lat. 33° 53′,) 66 9
That of the city of Buenos Ayres, (Lat. 34° 36′,) 67 5

In the northern hemisphere 60°.8 or 69°.8 of annual temperature corresponds to the same latitude in the northern hemisphere, according as we compare the American system of climates † or the Mediterranean one;—the concave or the convex

* *Mem. de l'Acad. de Lisbonne*, tome ii. p. 348. 369.

	Latitude.	Mean Temp.
† Natchez,	31° 28′,	64°.8
Cincinnati,	39 06,	53.8.

parts of the isothermal lines. At Port Jackson, where the thermometer descends sometimes below the freezing point, the warmest month is 77°.4, and the coldest 56°.8. We find here the summer of Marseilles and the winter of Cairo *. In Louisiana $2\frac{1}{2}$ of Lat. nearer the Equator, the warmest month is 79°.7, and the coldest 46°.9. In Van Diemen's Land, corresponding nearly in latitude to Rome, the winters are more mild than at Naples; but the coldness of the summers † is such, that the mean temperature of the month of February appears to be scarcely 64°.4, or 66°.2, whilst at Paris, under a latitude more distant from the Equator by 7°, the mean temperature of the month of August is also from 64°.4 to 66°.2, and at Rome above 77°. Under the parallel of 51° 25′ south, the mean temperature of the Malouine Isles is well ascertained to be 47°.3. At the same Lat. N. we find the mean temperature in Europe from 50° to 51°.8, and in America scarcely from 35°.6 to 37°.4. The warmest and the coldest months are at London 66°.2 and 35°.6; at the Malouine Isles 55°.8 and 37°.4. At Quebec, the mean temperature of the water is 14°; at the Malouine Isles 39°.6, though those isles are 4° of Lat. farther from the Equator than Quebec. These numerical ratios prove, that, to the parallels of 40° and 50°, the corresponding isothermal lines are almost equally distant from the Pole in the two hemispheres; and that, in considering only the system of transatlantic climates between 70° and 80° of W. Long., the mean temperatures of the year, under the corresponding geographical parallels, are even greater in the southern than in the northern hemisphere.

The division of the heat between the different parts of the year, gives a particular character to southern climates. In the

	Latitude.	Mean Temp.
* Cairo,	30° 2′	72°.3
Funchal,	—— 32 37	68 5
Algiers,	—— 36 48	70 0

† In Van Diemen's Land the thermometer descends in February, in the morning, to 45°.5. The mean of mid-day is 60°.8. At Paris it is in August 73°.4. In Van Diemen's Land, in February the mean of the maxima is 78°8.; of the minima 54°.5. At Rome these means are 86° and 64°.5.—D'Entrecasteaux, *Voyage*, tom. i. p. 205. and 542.

southern hemisphere on the isothermal lines of 46°.4 and 50°.0, we find summers which in our hemisphere belong only to the isothermal lines of 35°.6 and 40°. The mean temperature is not precisely known beyond 51° of S. Lat. Navigators do not frequent those regions when the sun is in the northern signs, and it would be wrong to judge of the rigour of winter, from the low temperature of the summer. The eternal snows which in 71° of N. Lat. support themselves at the height of 2296 feet above the sea, descend even into the plains, both in South Georgia * and in Sandwich Land in 54° and 58° of S. Lat. But these phenomena, however striking they may appear, do not by any means prove that the isothermal line of 32° is 5° nearer the South Pole than the North Pole. In the system of transatlantic climates, the limit of eternal snow is not at the same altitude as in Europe; and in order to compare the two hemispheres, we must take into account the difference of longitude. Besides, an equal altitude of the snows, does not by any means indicate an equal mean temperature of the year. This limit depends parcularly † on the coldness of summer, and this again on the quick condensations of the vapour caused by the passage of the floating ice. Near the poles the foggy state of the air diminishes in summer the effect of the solar irradiation, and in winter that of the radiation of the globe. At the Straits of Magellan, MM. Churruca and Galeano have seen snow fall in 53° and 54° of S. Lat. in the middle of summer; and though the day was 18 hours long, the thermometer seldom rose above 42°.8 or 44°.6 and never above 51°.8.

The inequal temperature of the two hemispheres, which, as we have now proved, is less the effect of the eccentricity of the

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* It is the more surprising to find in the Island of Georgia snow on the banks of the ocean, because 2° 39′ nearer the Equator at the Malouine Isles, the mean temperature of the summers is 53°.1, or 9° greater than at the point in our hemisphere in 71° of Lat. where the limit of perpetual snow exists at 2296 feet of absolute elevation. But we must recollect, 1st, That the Malouine Isles are near a continent which is heated in summer; 2d, That Georgia is covered with mountains, and is placed not only in a sea open to the north, but under the influence of the perennial ices of Sandwich Land; and, 3dly, That in Lapland, 20° of Lat. produce in certain local circumstances 10°.8 of difference in the temperatures of the summers.

† Baron Von Buch's *Travels in Lapland*, vol. ii. p. 393,—420.

earth's orbit, than of the unequal division of the continents, determines * the limit between the N. E. and S. E. Trade Winds. But as this limit is much more to the north of the Equator in the Atlantic Ocean, than in the South Sea, we may conclude that, in a region between 130° and 150° of W. Long. the difference of temperature between the two hemispheres, is less great than farther to the east in 20° or 50° of longitude. It is indeed under this region in the Great Ocean, that, as far as the parallel of 60°, the two hemispheres are equally covered with water, and equally destitute of dry land, which, radiating the heat during summer, sends the warm air towards the poles. The line which limits the N. E. and S. E. Trade Winds, approaches the Equator, whereas the temperature of the hemispheres is different; and if, without diminishing the cold of the southern atmosphere, we could increase the inflexion of the isothermal lines in the system of transatlantic climates, we should meet the S. E. winds in 20° and 50° of W. Long. to the north, and in 130° and 150° of W. Long. to the south of the Equator †.

The low strata of the atmosphere which rest upon the aqueous surface of the globe, receive the influence of the temperature of the waters. The sea radiates less absolute heat than continents; it cools the air upon the sea, by the effect of evaporation; it sends the particles of water cooled and heavier towards the bottom; and it is heated again, or cooled, by the currents directed from the Equator to the Poles, or by the mixture of the superior and inferior strata on the sides of banks.

It is from these causes combined, that, between the tropics, and perhaps as far as 30° of Lat., the mean temperatures of the air next the sea, are 3°.6 or 5°.4 lower than that of the continental air. Under high latitudes, and in climates where the atmosphere is coolest in winter, much below the freezing point, the isothermal lines rise again towards the Poles, or become convex when the continents pass below the seas ‡.

With respect to the temperature of the ocean, we must distinguish between four very different phenomena. 1*st*, The tem-

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* Prevost, *Journ. de Phys.* tom. xxxviii. p. 369.—Irish *Trans.* vol. viii. p. 374.

† Humboldt's *Relat. Histor.* tom. i. p. 225, 237. ‡ *Id.* p. 67, 230. 242.

perature of the water at the surface corresponding to different latitudes, the ocean being considered at rest, and destitute of shallows and currents. 2*d*, The decrease of heat in the superimposed strata of water. 3*d*, The effect of billows on the temperature of the surface water. 4*th*, The temperature of currents, which impell with an acquired velocity, the waters of our zone across the immoveable waters of another zone. The region of warmest waters no more coincides with the Equator, than the region in which the waters reach their maximum of saltness. In passing from one hemisphere to another, we find the warmest waters between 5° 45′ of N. Lat., and 6° 15′ of S. Lat. Perrins found their temperature to be 82°.3; Quevedo 83°.5; Churruca 83°.7, and Rodman 83°.8. I have found them in the South Sea to the east of the Galapagos Isles 84°.7. The variations and the mean result do not extend beyond 1°.3. It is very remarkable that in the parallel of warmest waters, the temperature of the surface of the sea is from 3°.6 to 5°.4 higher than that of the superincumbent air. Does this difference arise from the motion of the cooled particles towards the bottom, or the absorption of light, which is not sufficiently compensated by the free emission of the radiant coloric. As we advance from the Equator to the Torrid Zone, the influence of the seasons on the temperature of the surface of the sea becomes very sensible; but as a great mass of water follows very slowly the changes in the temperature of the air, the means of the months do not correspond at the same epochs in the ocean and in the air. Besides, the extent of the variations is less in the water than in the atmosphere, because the increase or decrease in the heat of the sea takes place in a medium of variable temperature, so that the *minimum* and the *maximum* of the heat which the water reaches, are modified by the atmospherical temperature of the months which follow the coldest of the warmest months of the year. It is from an analogous cause, that in springs which have a variable temperature, for example, near Upsal *, the extent of the variations of temperature is only 19°.8, while the same extent in the air from the month of January to August, is 39°.6. In the parallel of the Canary Islands,

* Gilbert's *Annalen*, 1812, p. 129.

Baron Von Buch found the minimum of the temperature of the water to be 68°, and the maximum 74°.8. The temperature of the air in the warmest of the coldest months, is, in that quarter, from 64°.4 to 75°.2. In advancing towards the north, we find still greater differences of winter temperature between the surface of the sea and the superincumbent air. The cooled particles of water descend till their temperature reaches 39°.2; and hence in 46° and 50° of Lat. in the part of the Atlantic which is near Europe, the *maximum* and *minimum of heat* are

In the water at its surface,	68°.0 and 41°.9
In the air from the mean of warmest and coldest months,	66.2 and 35.6

The excess in the mean temperature of the water over that of the air, attains its maximum beyond the polar circle, where the sea does not wholly freeze. The atmosphere is cooled to such a degree in these seas, (from 63° to 70° of Lat., and 0° of Long.) that the mean temperature of several months of winter descend on the continents to 14° and 10°.4, and on the coasts to 23° and 21°.2, while the temperature of the surface of the sea is not below 32° or 30°.2. If it is true, that even in those high latitudes the bottom of the sea contains strata of water which, at the maximum of their specific gravity, have 39°.2 or 41° of heat, we may suppose that the water at the bottom contributes to diminish the cooling at the surface. These circumstances have a great influence on the mildness of countries in continents separated from the Pole by an extensive sea.

Hitherto we have attended to the distribution of heat on the surface of the globe at the level of the sea. It only remains for us to consider the variations of temperature in the higher regions of the atmosphere, and in the interior of the earth.

The decrease of heat in the atmosphere, depends on several causes, the principle of which, according, to Laplace and Leslie *, is the property of the air to increase its capacity for heat by its rarefaction. If the globe was not surrounded by a mixture of elastic and aëriform fluids, it would not be sensibly colder at the height of 8747 yards than at the level of the sea. As each

* *Essay on Heat and Moisture*, p. 11.; and *Geometry*, p. 495.

part of the globe radiates in every direction, the interior of a spherical envelope which would rest on the top of the highest mountains, would receive the same quantity of radiant heat as the lower strata of the atmosphere. The heat, it is true, will be spread over a surface a little greater; but the difference of temperature will be insensible, since the radius of the spherical envelope will be to that of the earth as 1.001 to 1.

Considering the earth as surrounded with an atmospherical fluid, it is obvious, that the air heated at its surface will ascend, dilate itself, and be cooled, either by dilatation, or, by a more free radiation across the other strata that are equally rarified. These are the ascending and descending currents, which keep up the decreasing temperature of the atmosphere *.

The cold of mountains is the simultaneous effect, 1*st*, Of the greater or less vertical distance of the strata of air at the surface of the plains and of the ocean. 2*d*, Of the extinction of light, which diminishes with the density of the superincumbent strata of air †; and, 3*d*, Of the emission of radiant heat, which is favoured by air very dry ‡, very cold, and very clear. The mean temperature of our present plains would be lowered, if the seas should experience a considerable diminution. The plains of continents would then become *plateaux*, and the air which rested on them would be cooled by the circumjacent strata of air, which, at the same level, would receive but a small portion of the heat emitted from the dry bottom of the seas.

The following Table contains the results of observations which I have made near the Equator, on the Andes of Quito, and towards the northern extremity of the torrid zone, in the Cordilleras of Mexico. These results are true means, given either by stationary observations made during several years, or by insulated observations. In these last, we have taken into account the hour of the day,—the distance of the solstices,—the direction of the wind,—and the reflection from the plains.

* *Essay on Heat and Moisture*, p. 11.; and *Geometry*, p. 495.

† Humboldt on Refraction below 10°, *Observ. Astron.* tom. i. p. 126.

‡ Wells on *Dew*, p. 50.

Height above the Level of the Sea.	Cordilleras of the Andes. From 10° of North Lat. to 10° of South Lat. — Mean Temp. of the Year.	Examples, which may serve as a Type.	Mountains of Mexico. From 17° of North Lat. to 21° of North Lat. — Mean Temp. of the Year.	Examples, which may serve as a Type.
0 Toises. 0 Feet. (Comparative heights in Europe have been added for every 1000 metres.)	Fahr. 81°.5	*Cumana*, 33 *feet.* Temp. of day, 78°.8—86° ——— night, 71.6—74.3 *Maximum*, 90.9 *Minimum*, 70.2 Mean, - 81.9	78°.80	*Vera Cruz*, 0 *feet.* Temp. of day, 80°.6—86° ——— night, in summer, 78.26—82.4 ——— night, in winter, 66.2—75.2; 64.4—71.6 Mean Temp. 77.72
500 Toises. 3197 Feet. *Vesuvius* 3870 feet.	71°.24	*Caraccas*, 2906 *feet.* Temp. of day, 64°.4—73°4 ——— night, 60.8—62.6 *Maximum*, 78.3 *Minimum*, 54.5 Mean, - 69.4 *Guaduas*, 3769 feet. Temp. Mean, 67°.5	67°.64	*Xalapa*, 4330 *feet.* Temp. Mean in winter, 64°.76 ——— of day, 57°.2—59 *Chilpantzingo*, 4523 *feet*, on a plateau which radiates. Mean Temp. - 69°.08
1000 Toises. 6394 Feet. *Hospice of St Gothard*, 6806 feet.	64°.4	*Popayan*, 5815 *feet.* Temp. of day, 66°.2—75°.2 ——— night, 62.6—64.4 Mean, - 65.66 *Santa Fé de Bogota*, 8721 *feet.* Temp. of day, 59°—64°.4 ——— night, 50—53.6 *Minimum*, 36.5 Mean, - 57.74	64°.4	*Valladolid de Mechoachan*, 6396 *feet.* Mean Temp. 66°.2—68°. *Mexico*, 7468 *feet.* Temp. of day, 60°.8—69°.8 ——— night, 55.4—59 Warmest months, 52.7—59 Coldest months, 32—44.6 Mean, 62°.6
1500 Toises. 9591 Feet. *Canigou*, 9118 feet.	57°.74	*Quito*, 9538 *feet.* Temp. of day, 60°.08-66°.74 ——— night, 48.2--51.8 *Maximum*, 71.6 *Minimum*, 42.8 Mean, - 57.92	57°.2	*Toluca*, 8823 *feet.* Temp. Mean, - 59° *At the Nevado de Toluca*, 11,178 *feet.* Temp. of spring. 48°.2
2000 Toises. 12,789 Feet. *Peak of Teneriffe*, 12,169 feet.	44°.6	*Micuipampa*, 11,867 *feet.* Temp. of day, 41°—48°.2 ——— night, 35.6—31.28 *Les Paramos*, 11,480 feet. Mean Temp. in gen. 47°.12	45°.5	*At the Nivado de Toluca*, 12,178 *feet.* Temp. in Sept. at noon, 52°.7 *At Coffre de Perote*, 12,136 *f.* In February, at 9h, 50°.36
2500 Toises. 15,985 Feet. *Mont Blanc*, 15,662 feet.	37°.7	*At the Inferior Limit of Perpetual Snows*, 15,774 *feet.* Temp. of day, 39°.2—46°.4 ——— night, 28.4—21.2 *Chimborazo*, 19,286 feet. In June, at 1 o'clock, I have seen the therm. at 29°.12.	33°.8	*At the Pic del Fraille*, 15,157 *feet.* I have seen the thermometer in September at 39°.74.

The means given by the Mexican observations are a little different from those given by the observations on the Cordilleras. When the differences and the coincidences amount to about a degree of Fahrenheit, they may be regarded as purely accidental. The length of the day is more unequal in the 20th degree of latitude, but the perpetual snows do not descend 656 feet lower than under the Equator. As the Cordilleras of New Granada, Quito, and Peru, present a great number of points where stationary observations have been made, I shall collect here the mean temperatures which M. Caldas * and I have determined with some certainty, and which all belong to a zone bounded by the parallels of 10° N. and 10° S. Lat.

	Alt. in Feet.	Mean Temp.		Alt. in Feet.	Mean Temp.
Coasts of Cumana,	0	80°.6	Alausi,	7970	59°.00
		82.4	Pasto,	8308	58.28
Tomependa, Amazons R.	1279	78.44	Santa Rosa,	8459	57.74
Tocayma,	1581	81.5	Cuenca,	8633	60.08
Antioquia,	1666	77.00	Santa Fé de Bogota,	8721	57.74
Neiva,	1702	77.00	Hambato,	8849	60.44
Caraccas,	2906	69.44	Caxamarca,	9381	60.80
Caripe,	2959	65.3	Llactacunga,	9473	59.00
Carthago,	3149	74.84	Riobamba Nuevo,	9482	61.16
La Plata,	3437	74.66	Tunja,	9522	56.66
Guaduas,	3772	67.46	Quito,	9538	57.92
La Meya,	4225	72.50	Malbasa,	9971	54.50
Medellin,	4858	68.9	Plateau de los Pastos,	10099	54.50
Estrella,	5645	65.84	Les Paramos,	11480	47.30
Popayan,	5815	65.66	At the Inferior Limit of Perpetual tual Snow,	15744	34.88
Loxa,	6855	64.4			
Almaguer,	7413	62.6			
Pamplona,	8016	61.16			

These thirty-two points are not insulated points, as balloons would be if they were fixed in the atmosphere at a perpendicular height of 16,400 feet. They are stations taken on the declivity of mountains, upon that part of the solid mass of the globe which, in the form of a wall, rises into the higher regions of the atmosphere. These mountains, too, have at each height parti-

* I have used the mean temperature and barometrical measurements published at Santa Fé de Bogota by MM. Caldas and Restrepo in the *Semanario del N. R. de Granada*, tom. i. p. 273.; tom. i. p. 93.—341.

cular climates, modified by the radiation of the plateaus on which they stand,—upon the slope of the ground,—the nakedness of the soil,—the humidity of the forests,—and the currents which descend from the neighbouring summits.

Without knowing the localities themselves, the effect of disturbing causes will be readily seen, by comparing in the preceding Table the mean temperatures which correspond to the same elevations; and the discussion of these observations would prove, also, that the extent of the variations is much less than is generally believed. If we examine thirty-two temperatures, upon the hypothesis that a degree of cooling corresponds to an altitude of 200 metres (656 feet), we shall deduce the temperature of the plains (from 30°.6 to 82°.4) twenty-six times from that of elevated places. For the other six deductions, the temperatures differ only about 3°.6; and the errors of observation are here combined with the effects of localities. The air which rests on the plains of the Andes mixes itself with the great mass of the free atmosphere, in which there prevails under the torrid zone a surprising stability of temperature. However enormous be the mass of the Cordilleras, it acts but feebly on the strata of air which are unceasingly renewed. On the other hand, if the plains are heated during the day, they radiate as much during the night; for it is principally on the plains elevated 8856 feet above the sea, that the sky is most clear and uniformly serene. At Peru, for example, the magnificent plateau of Caxamarca, in which the wheat yields the eighteenth, and barley the sixtieth grain, has an extent of more than twelve square leagues: it is smooth like the bottom of a lake, and sheltered by a circular wall of mountains free from snow. Its mean temperature is 60°.8, yet the wheat is often frozen during the night; and in a season where the thermometer fell before sunrise to 46°.4, I have seen it rise in the day to 77° in the shade. In the vast plains of Bogota, which are 656 feet less elevated than that of Caxamarca, the mean temperature, as established by the fine observations of Mutis, is scarcely 57°.74.

In comparing towns situated on elevated plains with those which are placed on the declivity of mountains, I have found for the first an augmentation of temperature, which, on account of the nocturnal radiation, does not exceed from 2°.7 to 4°.14. This augmentation is a little greater in the lower regions of the Andes, in those large valleys whose smooth bottoms reach the height of from 1312 to 1640 feet, principally in the valley of La Madaleine, between Neiva and Houda. It is singular to find in the middle of mountains heats which equal those of the plains, and which are more insupportable, as the air of the valleys is almost never agitated by the winds. If we compare, however, the mean temperatures of these same places with those of the strata of the true atmosphere, or on the declivity of mountains, we shall find them only from 3°.6 to 5°.4.

On these grounds, we may place some confidence on the four results which we have deduced from such a great number of observations, for the perpendicular heights of 1000, 2000, 3000, and 4000 metres. I have confined myself to a simple arithmetical mean, and to the fortuitous compensation of irregularities; for I could not have avoided employing an hypothesis on the decrease of heat, if I had wished to reduce to a standard height those heights which approach it the most. I have added the observations with which an intimate knowledge of localities has furnished me.

1. *For* 1000 *Metres* (3280 *feet*) *of Elevation.*	Alt. in Feet.	Temp. Fahr.
Convent of Caripe, (thick and damp forests), -	2959	65°.3
Caraccas, (a foggy sky, valley of small extent,) -	2906	69.44
La Plata, (very warm, valley communicating with that of L'Alto Magdalena,) - - - -	3437	74.66
Carthago, (very warm valley of Cauca), - -	3149	74.84
2. *For* 2000 *Metres* (6560 *feet*) *of Elevation.*		
Loxa, (a plateau of small extent), - -	6855	64.4
Almaguer, declivity covered with very thick vegetation), -	7413	62.6
Popayan, (small plateau, a little elevated above the valley of Cauca,) - - - - -	5815	65.66
3. *For* 3000 *Metres* (9840 *feet*) *of Elevation.*		
Caxamarca, (very extensive plateau, sky serene,) -	9381	60.80
Quito, (at the foot of Pinchincha, a narrow valley,) -	9538	57.92
Tunja, (mountains of New Grenada), - -	9522	56.66
Malvasa. (elevated plains, cooled by the snows of the volcano of Puracé,) - - - -	9971	54.50
Los Pastos, (very cold plateau, from which rise snow-covered summits,) - - - - -	10099	54.50
Llactacunga, (temperate valley), - -	9473	59.0
Riobamba Nuevo, (arid plains of Tupia, covered with pumice-stone,)	9482	61.16

Between the tropics, the Cordilleras form the centre of the civilization and industry of Spanish America. They are inhabited to the height of 4000 metres, (13,120 feet); and a small number of observations made on the back of the Andes, gives a sufficiently accurate idea of the mean temperature of the year. In Europe, on the contrary, in the temperate zone, the high mountains are in general little inhabited. The descent of the isothermal line of 32°, causes to cease the cultivation of crops of grain, at the point where they begin in the Cordilleras. Stationary habitations are rare above 2000 metres (6560 feet) of elevation; and in order to judge with any precision of the mean temperature of the superincumbent beds of air, we must unite at least 730 thermometrical observations made in the course of a year *.

* Elevations of 400 metres (1312 feet) appear to have a very sensible influence on the mean temperature, even when great portions of countries rise progressively. In order to establish this point, I have examined the temperatures of places situated almost on the level of the sea, and under the same parallels.

	Lat.	Elevation in Feet.	Mean Temp.
Buda, - - -	47°.29	512	51°.08
Paris, - - -	48.50	116	51.08
Vienna, - - -	48.12	551	50.54
Manheim, - -	49.20	384	50.18

Whence, in the longitudes of Paris and Buda, and between the latitudes of 47° and 48°, and almost at the level of the sea, the mean temperature is from 50°.9 to 51°.44.

Under the same longitudes, we have,—

	Elevation in Feet.	Mean Temp.
Geneva, - - -	1177	49°.28
Zurich, - - -	1437	47.84
Munich, - - -	1711	50.74
Berne, - - -	1755	49.28
Marschling, - -	1834	51.98 *
Coire, - - -	1991	48.92 †

By taking the means of these results, we cannot mistake the influence of *small elevations*, or of very *extensive plateaus*, on the decrease of the mean temperature.

* Heated by the winds of Italy.

† In spite of the winds of Italy.

Places situated between 46°—47° of North Lat.	Elevations.		Mean Temperatures.		
	Metres.	Feet.	Of the Year.	Of the Coldest Months.	Of the Warmest Months.
Level of the sea,	0		53°.60	36°.32	69°.80
Geneva,	359	1177	49.64	34.16	66.56
Tegernsée,	744	2440	42.44	22.10	59.36
Peissenberg,	995	3264	41.00	20.84	57.02
Chamouni,	1028	3372	39.20		55.40
Hospice de St Gothard,	2076	6809	30.38	15.08	46.22
Col de Géant,	3436	11270	21.20		36.50

In comparing the mean temperature of superincumbent beds of air, I find that the isothermal line of 41°, which, in the parallel of 45°, is found at the height of 1000 metres, (3280 feet), makes the equatorial mountains of an absolute elevation of 4250 metres, (13,940 feet). It had, however, been long believed, after Bouguer, that the inferior limits of perpetual snows characterised every where a bed of air, whose mean temperature was 32°; but I have shewn in a Memoir read to the Institute in 1808 *, that this supposition is contrary to experience. By uniting good observations, I have found, that at the limit of perpetual snows, the mean temperature of the air is,—

	Metres.	Feet.	Mean Temp. of Limit of Perpetual Snows.
At the Equator,	4800	15,744	34°.70
In Temperate Zone,	2700	8,856	25.34
In Frigid Zone, in Lat. 68°—69°,	1050	3,444	21.20

As the heat of the higher regions of the atmosphere depends on the radiation of the plains, we may conceive, that, under the same geographical parallels, we cannot find, in the transatlantic climates, (on the declivities of rocky mountains), the isothermal lines at the same height above the level of the sea as in European climates. The inflexions which these lines experience, when traced on the surface of the globe, necessarily influence their position in a vertical plane, whether we unite in the atmosphere points placed under the same meridians, or consider only those that have the same latitude.

Hitherto we have attempted to determine the mean temperatures which correspond under the Equator and in Lat. 45° and

* *Observations Astronomiques*, tom. i. p. 136.

47° to beds of the atmosphere equally elevated. This determination is founded on stationary observations, and indicates the mean state of the atmosphere. General physics has its numerical elements, as well as the system of the world; and these elements, so important in the theory of barometrical measurements and in that of refractions, will be perfected in proportion as natural philosophers shall direct their attention to the study of general laws.

Height, in		Equatorial Zone, from 0°——10°.		Temperate Zone, from 45°——47°.	
Metres.	Feet.	Mean Temp.	Diff.	Mean Temp.	Diff.
0	0	81°.50		53°.60	
974	3195	71.24	10°.26	41.00	12°.60
1949	6393	65.12	6.12	31.64	9.36
2923	9587	57.74	7.38	23.36	8.28
3900	12792	44.60	13.14		
4872	15965	34.70	9.90		

This Table proves, in conformity with the deductions of theory, that in the mean state of the atmosphere, the heat does not decrease uniformly in an arithmetical progression. In the Cordilleras, (and the fact is extremely curious), we observe the decrease getting less and less between 1000 and 3000 metres, particularly between 1000 and 2500 metres of elevation, and then increasing anew from 3000 to 4000 metres. The strata, where the decrease attains its *maximum* and its *minimum*, are in the ratio of 1 to 2. From the height of the Caraccas to that of Popayan and Loxa, 1000 metres produce a difference of 6°.3. From Quito to the height of Paramos, the same 1000 metres change the mean temperature more than 12°.6. Do these phenomena depend only on the configuration of the Andes, or are they the effect of the accumulation of clouds in the aërial ocean? In considering that the Andes form an enormous mass, 3600 metres (11,808 feet) high, from which rise peaks or domes insulated and covered with snow, we may conceive how, from the point where the mass of the chain diminishes so rapidly, the heat decreases also with rapidity. It is not easy, however, to explain, by an analogous cause, why the progressive cooling diminishes between 1000 and 2000 metres. The great plateaus of the Cordilleras commence only at the height of 2600 or 2900 metres, (8528 or 9512 feet); and I am of opinion, that the slowness with which the heat decreases in the stratum of air between 1000 and 2000, is the triple effect of the extinction of light, or the absorption of the rays in the clouds,—of the formation of rain,—and the obstacle which the clouds oppose to the free passage of radiant heat. The bed of air of which we speak, is the region in which are suspended the large clouds which the inhabitants of the plains see above their heads. The decrease of temperature, which is very rapid from the plains to the region of clouds, becomes less rapid in that region; and if this change is less sensible in the temperate zone, it is no doubt because at the same height, the effect of radiation there is less sensible than above the burning plains of the equinoctial zone. In these zones, too, the cooling appears to follow the same law in the beds of air of equal temperature; but the force of radiation varies with the temperature of the radiating beds.

The results which we have now discussed, deserve the preference over those which are deduced from observations made during excursions to the tops of some lofty mountains. The first give for the

	Metres.	Cent.		Fahr.		Metres.
Equinoctial Zone,	0—4900	1°	or	1°.8	for	187 *
Temperate Zone,	0—2900	1°	or	1°.8	for	174

* This is the mean result or the measure of the distribution of heat in the whole column of air. The partial results are from the back of the Andes.

Heights in Metres.	Cent.		Fahr.		Metres.
0—1000	1°	or	1°.8	for	170
1000—2000	1	or	1.8	for	294
2000—3000	1	or	1.8	for	232
3000—4000	1	or	1.8	for	131
4000—5000	1	or	1.8	for	180

In these numbers, we recognise, as in the above Table, the influence of the region of clouds upon the decrease of heat. In order to shew the utility of these numerical ratios, I shall give here the approximate calculation of the height of the plain of Thibet, deduced from the mean temperature of the month of October, which, according to the former, is 42°.26. As the latitude of Tissoolumbo 29°, gives 69°.8 for the mean temperature of the plain; and as at Mount St Gothard, the mean

The last give for the

	Cent.		Fahr.	Metres.
Equinoctial zone, -	1°	or	1°.8	190
Parallels of 45°—47°, -	1°	or	1°.8	160—172 *

This agreement is no doubt very remarkable, and the more so, as, in comparing stationary with insulated observations, we confound the mean state of the atmosphere in the course of a whole year with the decrease which corresponds to a particular season, or a particular hour of the day. M. Gay-Lussac found, in his celebrated aëronautical voyage from 0 to 7000 metres, (0 to 22,960 feet), a centigrade degree for 187 metres, near Paris, at a period when the heat of the plains was nearly equal to that of the equinoctial region. It is on account of this observed equality in the decrease of heat, in reckoning from the standard temperature of the plains, that the astronomical refractions corresponding to angles below 10°, have been found the same under the equator and in temperate climates. This result, contrary to the theory of Bouguer, is confirmed by observations which I have made in South America, and by those of Maskelyne at Barbadoes, calculated by M. Oltmanns.

We have seen, that between the tropics, on the back of the Cordilleras, we find, at 2000 metres of elevation, I will not say the climate, but the mean temperature of Calabria and of Sicily. In our temperate zone, in 46° of Lat. we meet at the same elevation with the mean temperature of Lapland †. This comparison

temperature of October is even a little below that of the whole year, it is probable that the height of the plain of Great Thibet exceeds from 2900 to 3000 metres.—See my Memoir on the Mountains of India in the *Ann. de Chim. et de Phys.* 1817.

Note by the Editor.

As the cold meridian of the globe passes through the plains of Great Thibet, we conceive that the mean temperature of Lat. 29° in that plain, when reduced to the level of the sea, will be about 65°, and therefore that the height of the plain of Great Thibet will not exceed 2800 metres or 9184 feet.—D. B.

* Saussure gives for the summer 160 metres, (525 feet); for winter 230, (754 feet); and for the whole year 195, (640 feet). M. Ramond gives 165, (538 feet). M. D'Aubuisson 173 metres, (567 feet).—See *Journ. de Phys.* tom. lxxi. p. 37.; *De la Formul. Barometr.* p. 189.; and my *Recueil d'Obs. Astron.* tom. i. p. 129.

† As the temperature varies very little in the course of a whole year in the equinoctial zone, we may form a pretty correct idea of the climate of the Cordil-

leads us to an exact knowledge of the numerical ratios between the elevations and the latitudes, ratios which we find indicated with little precision in works on physical geography.

The following are the results which I have obtained from exact data in the temperate zone, from the plains to 1000 metres of elevation. Every hundred metres of perpendicular height, diminishes the mean temperature of the year, by the same quantity that a change of 1° of latitude does in advancing towards the Pole. If we compare only the mean temperature of summer, the first 1000 metres are equivalent to 0°.81 Fahr. From 40° to 50° of latitude, the mean heat of the plains in Europe decreases in Europe 12°.6 of Fahr.; and this same decrease of temperature takes place on the declivity of the Swiss Alps from 0 to 1000 metres of elevation.

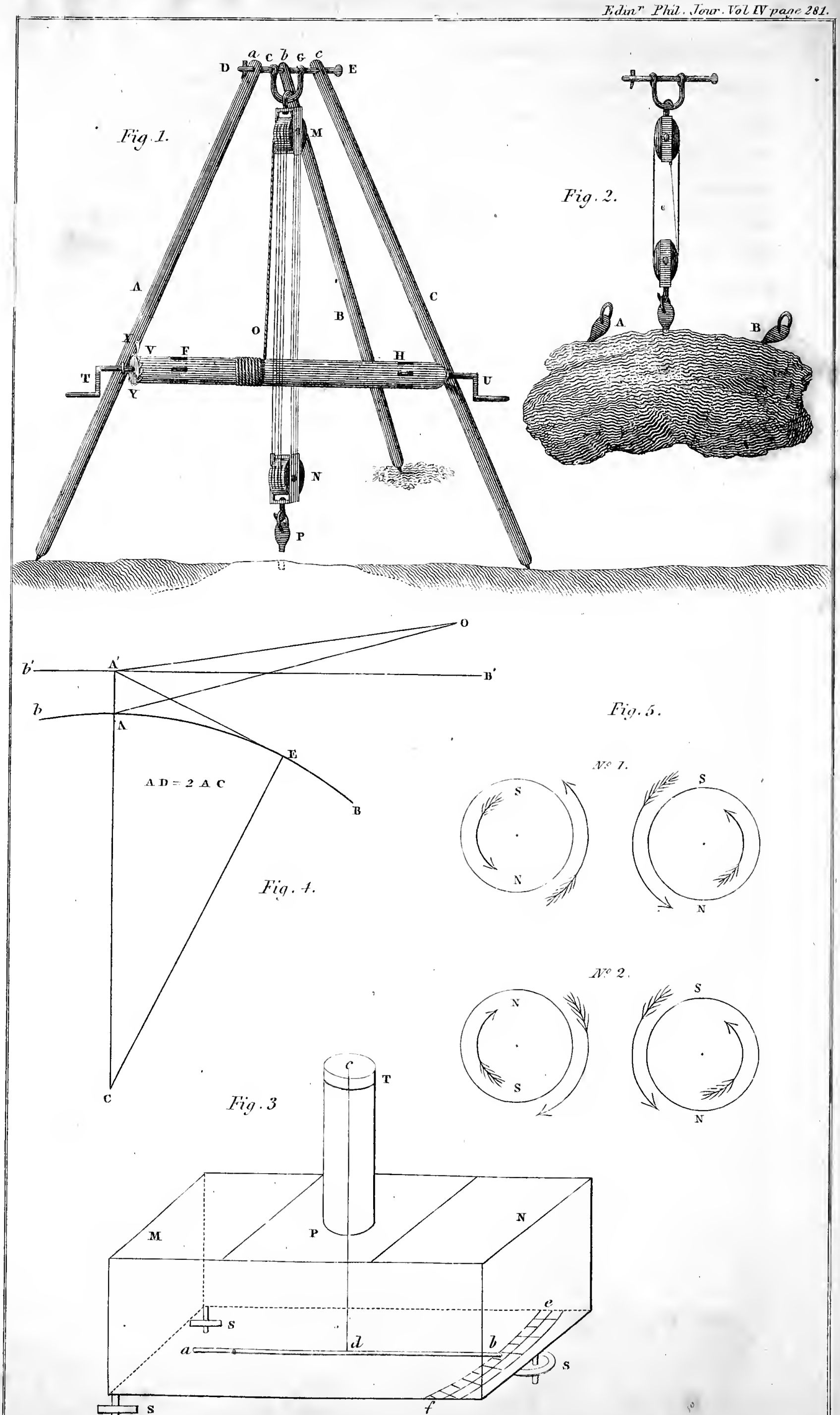
Differences of Latitude, Compared with Differences of Elevation.	Mean Heat of the Year.	Mean Heat of Summer.	Mean Heat of Autumn.
I. *At the Level of the Sea.*			
a. Latitude, 40°;	63°.14	77°.00	62°.60
b. Latitude, 50°,	50.54	64.40	
II. *On the Declivity of Mountains.*			
a. At the foot in 46° of Lat.	53.60	68.00	51.80
b. At an elevation of 1000 metres,	41.00	58.46	42.80

These numerical ratios are deduced from observations made on the temperature of the air. We cannot measure the quantity of heat produced by the solar rays on the parenchyma of plants, or in the interior of fruits which receive their colour in ripening. The fine experiment of MM. Gay-Lussac and Thenard, the combustion of chlorine and hydrogen, proves what a powerful action direct light exercises on the molecules of bodies. But as the extinction of light is less upon the mountains in dry and rarified air, maize, fruit-trees, and the vine, still flourish at heights which, according to our thermometrical observations made in the air, and far from the ground, we ought to suppose

leras, by comparing them to the temperature of certain months in France or in Italy. We find in the plains of Orinoco the month of August of Rome; at Popayan, (2988 feet), the month of August of Paris; at Quito (4894 feet), the month of May; in the Paramos, (5904 feet), the month of March at Paris.

PLATE VI.

Edinr Phil. Jour. Vol. IV page 281.



W. Archibald Sculpt Edinr

Published by A. Constable & Co Edinr 1821.

too cold for the cultivation of plants useful to man. M. De Candolle, indeed, to whom the geography of vegetables owes so many valuable observations, has seen the vine cultivated in the south of France at 800 metres (2624 feet) of absolute height, when, under the same meridian, this same cultivation went on with difficulty at 4° of latitude farther north; so that if we consider only the ratios in France, an elevation of 100 metres, (328 feet), appears to correspond, not to 1°, but to half a degree of latitude *.

(To be concluded in next Number.)

Art. VII.—*Description of a Machine for Raising Stones.* By David Low, Esq. †

The curious machine to be now described, has been employed in some places for the purpose of clearing uncultivated ground of such large masses of granite or whinstone, as could not be moved but by the aid of gunpowder. It is, I believe, very little known; and yet, as an useful instrument, it well deserves attention. As it affords, besides, the means of making a very singular philosophical experiment, I trust that a page or two of the Edinburgh Philosophical Journal may be well employed in disseminating a knowledge of its properties and construction. With this view, I shall endeavour to describe a convenient form in which it can be made for practical uses, and the purposes of experiment.

In Plate VI. Fig 1. A, B and C represent three strong wooden posts, about 14 feet in length, through the ends of which

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* See my *Prolegomena de Distributione Plantarum*, p. 151. 163. The small differences between the numbers given in the Prolegomena and in this Memoir, written subsequently, should be ascribed to the constant desire which I have had to perfect the mean results.

† This machine was invented by Mr Richardson of Keswick, who was rewarded for the invention by the Society of Arts. We have not heard of its having been used to any extent in England, but in Scotland it has met with high approbation wherever it has been employed, though we believe it is but little known among that class to whom it is likely to be of the greatest utility.—D. B.

are three holes *a b c*, for the reception of the strong iron pin, DE, upon which is made to slide the curved iron-bar CG. The pin is so thrust through the holes in the posts already mentioned, that the post C of Fig. 1. shall be next to the thick end of the pin E; the post B in the middle at *b*, within the bend of the crooked bar CG, and the post A next to the pin at D, which is thrust through the other to keep the apparatus together. The holes *a b c* being of such a size as to allow a little play to the posts, these last may be stretched out like the legs of the common theodolite, in the manner represented in Fig. 1. To the curved iron-bar are then attached the fixed block M, containing four or more pulleys, and the moveable block N, containing the like number of pulleys. Each of these blocks must be hooped with a very strong bar of iron, and the pulleys must be of a size to admit of a thick rope passing over them. To the lower block N is to be hooked the iron plug P, consisting of a ring, a flat part, and a cylinder. The cylindrical part may be 7–8ths of an inch in diameter at the point, gradually increasing to about the 16th part of an inch more in diameter at the neck, and being about 2 inches in length. The end of the rope O, in Fig. 1. passing over the fixed pulleys, is attached to the windlass FH, which may be 6 feet or more in length, and which is fixed by its axis to the posts A and C. At each end of this windlass is a winch T and U, for the purpose of saving time, by tightening the ropes previous to the windlass being worked. The windlass is worked in the usual manner, by levers, for the reception of which are mortises, as shown in the figure. At one end of the windlass is fixed the ratchet wheel VY, (the catch X being fixed to the post A,) for the purpose of preventing the weight from falling back when the moving power is withdrawn. The two posts A and C should be connected by a cross bar, to keep them steady in their place.

The machine thus described is easily managed. It is placed over the stone to be raised, by extending the posts on each side, and then the windlass is attached. Of the stone to be thus raised, however large it be, it is enough to see the smallest part appear above the surface of the ground. At this part let a workman, with a mallet, and the common steel-boring chisel of masons, make a small circular hole, about two inches deep, and as perpendicular as possible. This chisel should be of such a size as to make the hole about a sixteenth part of an inch less in diameter than the plug itself, so that a stroke or two of a hammer may be necessary to drive the iron home. When the latter is thus driven an inch, more or less, into the stone, it is attached to the block, and the ropes are tightened by turning the winch. Nothing more is now requisite, than to set as many persons as may be required to work the windlass; and, strange as it will seem, with no other fastening than this simple plug, the heaviest mass will be torn up through every opposing obstacle, and lifted into the air.

I could well pardon incredulity in any one who was, for the first time, told of such an effect produced by such means. When the fact was mentioned to some distinguished men of science in this country, they remained incredulous, and were only convinced by seeing the engine itself at work; and I have not heard that any of these gentlemen have explained the principle of action of the machine. I understand that the general opinion, on first witnessing the experiment, was, that the iron-plug, when driven into the stone, was not precisely in the direction of the moving power, and that the mass was raised and suspended in the manner shown by the plugs A and B, in Fig. 2. This explanation, I apprehend, cannot be admitted; and it is to the elasticity of the stone, and not to the direction of the moving force, that we must attribute the effect produced. The iron is forced down by a stroke, and retained in its position by the elastic power of the stone, in the same manner as a similar pin would be held by a block of wood, into which it was forced by the same means, with this difference, that the elastic power exerted upon the iron by the harder stones, would be incomparably greater than that exerted by the wood. That this is the true explanation of the phenomenon, is confirmed by the facts of the experiment itself: For, 1*st*, It is found, that the moving power may be made to act in the direction of the hole with the utmost precision, without varying in the least the result; 2*d*, That when the mass is raised from the earth, it may be moved into any position without being detached; and, 3*d*, That, while hardly any constant force will pull out the plug, a smart stroke or two of a hammer will do so with ease. Doubtless the force with which the iron is retained, will diminish with the elasticity of the stone; so that it will be vastly less in the softer stones, as in freestone, than in granite, marble, and the like. Indeed, I believe it is only in the latter species of stones that the experiment can be made with effect.

A person might conceive how a large mass of stone might be held suspended, in certain cases, in the manner before adverted to; but we cannot account for masses being raised in this manner from every variety of horizontal and inclined position; nor conceive how, if this were the mode in which the two bodies were kept attached, it should happen, that while no constant force that can be exerted, in whatever direction, will loosen the little piece of iron, the force of percussion will do so at once. Let any one procure a plug of the form described, and attach it in the manner mentioned, to a mass of granite, and, instead of using machinery, let him pull the rope with the hand in any direction, and he will as soon move a tower from its base as the little plug from its position; so certainly is it the grasping of the stone, and not the direction in which the rope is pulled, that keeps the mass attached. In making the experiment with the machine, it is even necessary to be careful that the hole shall be made as perpendicular as possible; for, if made in the direction represented by the plugs A or B, in Fig. 2., that part of the stone is apt to give way which lies between the iron and the surface. We shall often be surprised, in trying the experiment on large pieces of granite, to observe with how slight a seeming hold of the stone the masses will be torn up. Sometimes the iron-pin is not driven above the fourth part of an inch into the stone before it becomes immoveable, and capable of raising a weight of many tons from the earth.

When we consider the greatness of the elastic power of granite, as shown by the simple experiment in question, we may perhaps wonder, that the ingenuity of man has not hitherto more applied so surprising a property to practical uses. It appears, that, with a little piece of iron driven into a stone, with a force which a child might exert, the largest vessels might be moored; that by the same means masses of granite might be nailed, as it were, together, with a force which could hardly be overcome; and that rocks themselves may be suspended in the air.

GORDONBANK, }
December 9. 1820. }

ART. VIII.—*Analysis of Mr Scoresby's Account of the Arctic Regions, being a Translation of the Official Report of MM.* ROSSILY *and* ROSSEL, *to Baron Portal, Minister of the French Marine* *.

IN consequence of the letter in which your Excellency requests from M. Count de Rossily, Director of the Depot of Charts and Nautical Plans, a report on the different subjects treated in this work, and its probable utility to navigation and commerce, we, M. Le Chevalier de Rossel and I, have examined it, and we can assure your Excellency, that for a long time we have not seen any nautical work containing more solid information, or the subject treated more systematically.

The details into which we are about to enter, will enable your Excellency to judge of what importance it will be to disseminate it among the seamen destined to navigate the northern seas, and also among the merchants who may be tempted to speculate in the whale-fishery. Both will here find all that an enlightened experience can communicate on the dangerous navigation of seas encumbered with ice, or on the advantages and risks of that fishery.

The work consists of two octavo volumes, of above 500 pages, each containing one of the two distinct subjects announced in the general title: The first volume embraces a geographical and hydrographical description, the most complete hitherto published, of the countries and seas around the North Pole, while the second treats only of what is immediately connected with the whale-fishery and its products.

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* We have been indebted to Dr Traill for the translation of this very interesting document, which has not been published in the original; and we trust it will give much satisfaction to our readers, to see that the high merit of Captain Scoresby has been well appreciated in a foreign country.—D. B.

In the commencement of the first part, the author examines the probability of a communication between the Atlantic and Pacific Oceans, both in a north-west and a north-east direction; and then gives a historical summary of all the attempts which have been hitherto made to discover it. It would, without doubt, be equally imprudent to assert or to deny its existence, and the author leaves it undecided. He contents himself with a very just remark, which is indeed a consequence immediately deduced from the experience of those navigators who have attempted this passage:—that, should it exist, there would be a necessity to winter among the ice in making the discovery, and very probably in afterwards making a practical use of it. This opinion is founded on very solid reasoning, which is supported by facts drawn from the voyages, of which he has given a compendium.

The most remarkable character of this work is, that the reasoning in every step is supported by experiments deduced from ordinary practice, or from the most delicate and abstruse physical investigations. No general idea is discussed, of which the conclusion is not supported by some fact observed by the author, or communicated to him by persons worthy of credit.

Whenever he treats of scientific subjects, he cites the names best known and most celebrated in England,—a remark which is equally applicable to the other parts of his work.

General remarks on the Polar Seas and Regions form the subject of the first chapter; the second contains a detailed hydrographic description of all that is known respecting the coasts of Spitzbergen and Jan Mayen's Island, as also of some smaller islands not far distant.

All these descriptions have the advantage of being, as much as was in the author's power, historical and geographical, and are in general either drawn from the best sources of information, or from his own observations. Although the second chapter is chiefly composed from very widely circulated voyages, it is gratifying to find knowledge of so great importance to navigation collected into one view with such order and precision.

The subject of the 3d, 4th, and 5th chapters is peculiarly Captain Scoresby's own, and we should search in vain to discover any other work in which it is treated with such connection and detail. The 3d chapter is entitled Hydrographic Survey of the Greenland Sea *. The author first assigns the limits of that portion of the ocean which he names the Greenland Sea, and then enters into all the details of the colour it assumes in different places, of its various qualities, its specific gravity, and its degree of saltness.

He notices the temperature of water drawn from different depths, the degree of pressure which it there sustains, and describes an instrument which enabled him to make experiments on these latter subjects. The chapter concludes with some highly interesting remarks on the rapidity and direction of currents in general. The author extends his researches to a summary abstract of what is known on the formation of waves, on the causes of their greater or less elevation, and on the effects which they produce, when several billows coming in different directions meet in the same place.

The 4th chapter, of nearly 100 pages, is a complete and well arranged treatise on the Ices of the Greenland and Polar Seas in general.

The author, in the first place, endeavours to fix definite ideas to the terms employed by seamen to designate the different forms assumed by the ice, with which the Polar Seas are often encumbered, and sometimes wholly covered; whether the masses of ice, connected together, present the aspect of a continuous plain, or the image of a country bristled with hills; whether they consist of detached pieces in continual motion, that threaten by their collision to crush to pieces the ships entangled among them, or impinging against them, or, whether, reduced to smaller pieces, they form a barrier, through which it is not always safe to force a passage.

The precision of the author's descriptions greatly contributes to throw a clear light on what he afterwards says of the formation of the different kinds of ice, of the causes which collect them into masses of prodigious extent, or which shiver them into minute fragments. The isolated mountains of ice resembling floating islands, are also the subject of his researches.

The author, in any of his descriptions, however alluring

* The learned reporters have here erred; they say, "*Description des eaux et de la mer.*"

they may be, never for one moment loses sight of his principal object, which is the improvement of navigation; he unfolds the dangers to which ships are exposed, and teaches the means of extricating them; he determines the limits which the ices occupy in different seasons, and points out the times of the year when certain latitudes should be frequented in preference to others, without omitting what experience has taught us regarding the variations those limits may undergo in the same season. The reciprocal effects of ice of a certain extent on the atmosphere, and of the atmosphere on the ice, have not escaped the inquiring mind of Mr Scoresby. From these he has deduced arguments, which very naturally explain how strong gales, and even violent storms, occupy so small an extent in icy seas, that if several vessels be separated from each other, but yet in sight, some may be impelled by an impetuous gale, while others are becalmed, or have only a moderate breeze. All the phenomena are discussed with clearness, and lead our author to an examination of the grand question, Whether it be possible to find a navigable sea to the North Pole; and he inclines to the opinion of those who are sceptical on the subject: 1*st*, He grounds this belief on the general principle, that effects should augment with the intensity of the causes which produce them; 2*d*, On the experience of the multitude of vessels, for many ages, employed in the Whale-fishery in high latitudes, which have always met with an icy barrier, of which the limits, indeed, are more or less distant, but which has never been passed beyond the 82d parallel of latitude.

The subjects of the four first chapters are immediately interesting to navigation; some of them have never before been systematically treated; and if they have been occasionally introduced, it has only been as the subject of isolated reflections: But in this work, all the facts which relate to the same phenomenon are brought together; and the author, not confining himself to a judicious deduction of causes from their effects, frequently unravels, with much sagacity, the modifications of which both are susceptible.

His general method of procedure is an example of what may be accomplished by deliberate experience, aided by solid information; and it would be very advantageous to make it known among seamen. To us Captain Scoresby appears to unite that genius for observation, which has rendered the narratives of Dampier so instructive and attractive, with a mind beyond comparison more enlightened.

The 5th Chapter appears to belong rather to general physics than to navigation; yet, in fact, it is not wholly foreign to this art, since it treats of causes which exert great influence on the prevailing winds, and leads to an explanation of the use of the barometer in predicting the weather, from the oscillations of the mercury. The title is "Observations on the Atmospherology of the Arctic Regions, particularly relating to Spitzbergen and the adjacent Greenland Sea." The author first speaks of the climate, which in general is alternately excessively cold and humid; he afterwards explains its effects on inanimate substances, and on the human body; and he finally treats of the temperature of the Polar Regions. Aided by experiments carried on in the civilised countries nearest the icy seas, and by the hypotheses which philosophers have thence deduced, he attempts, by an ingenious method, to estimate the mean temperature of different parallels near the Pole, and also of the Pole itself. The author next gives the result of his experience on the extremes of the barometric column during the fishing season; and he deduces, from a series of twelve years observations, the relation between the weather, and the variations in the height of the mercurial column.

These interesting results, of easy application, are followed by remarks on the appearance, the colour, the transparency, the density, the moisture and the dryness of the atmosphere, and its state of electricity. The subject which concludes the fifth chapter is not less interesting than those which preceded it. The author here details the phenomena of the extraordinary atmospheric refractions of those climates; he adds some observations on the prevailing winds in icy regions; and some remarks on the aqueous meteors, as on the causes of clouds, rain, hail and snow, frost-rime, hoar-frost, and fogs. We find in the accompanying discussions, the principles of the soundest physics, supported by all the knowledge which modern times have introduced into science.

Undoubtedly the explanations which Captain Scoresby has given of these phenomena, must, to a certain extent, be regarded as hypotheses more or less ingenious; and the publication of these cannot be of the same utility as that of the facts on which they are founded. Yet the minute research which it was necessary to make into all those facts; the examination of their mutual connection, and their subsequent arrangement, for the purpose of obtaining results applicable to practice, will prove a valuable assistance to those who prosecute similar researches, and especially contribute to perfect what may, in some measure, be called the *Science of Observation.* It is in this last point of view that the work of Captain Scoresby is particularly commendable. One may perceive, through the whole of his work, a man attached to his duty, who, to fulfil it well, has his attention unremittingly turned to all that passes around him; and who, endowed with a just perception, has accustomed himself to reason on what he observes.

The 6th and last chapter of the first volume, contains an Essay on the Zoology of the Polar Regions, embracing a description of the animals ascertained to live on the land, or in the icy sea which surrounds it. This last subject completes the description of the Arctic Regions. It has no relation to navigation, but is so naturally allied to the whale-fishery, the subject of the second volume, that the author could not avoid introducing it in the general plan of his work: but it is kept within due bounds. His descriptions become more enlarged when he treats of the different species of whales, of fish, or of other animals which may become objects of the fishery; of other quadrupeds he only treats when a description of them can excite curiosity. The details he gives of birds are most intimately connected with the principal design of the work; for he regards them as indicating, by their assembling at particular spots, the places where the whales retire, in order to avoid the crowds of fishers, who harass them on all sides. He points out the species which afford the most certain indications on this head.

The second volume, as we have already said, is wholly occupied with the Whale-fishery in the Arctic Regions, or rather in the seas partially covered with ice; for it is this last circumstance which gives a peculiar character to the fishery in the vicinity of

Spitzbergen, of Greenland, and in the Straits of Davis and Hudson. The mode of conducting it is so different in some respects from the fishery in the open sea, as to demand a separate description. This treatise may not be applicable to navigation in general; but no person who would speculate, or become practically engaged, in the whale-fishery, should pass it over, if he wishes to reap the greatest advantage from his speculations, or his labours. All the chapters and their subdivisions, in this second part, relate to the same object; and as it would be useless to analyse each chapter or its subdivisions, we shall content ourselves with a summary of what is best adapted to shew the manner in which the author treats his subject; taking especial care to preserve the connection of ideas, which is as conspicuous in this second, as in the first volume.

A chronological history of the whale-fishery occurs in the beginning of the second part; and the author immediately afterwards glances at the origin and progress of this fishery, and its actual state among the different maritime nations that have successively pursued it. This introduction, which appears solely applicable to the history of the whale-fishery, is not compiled merely to satisfy curiosity. From documents that seem entitled to credit, the author has given an estimate of the profits which each nation has derived from the fishery at certain periods, in such a manner, that one can trace its progress, among each people, from its commencement to the period of its highest success; and also perceive the causes of its decline. It is remarkable that the English, who have carried this trade to a higher pitch than any other nation, were the last to begin it, and have even applied to it but very recently. The real cradle of the whale-fishery is Biscay, the conterminous provinces of France and Spain; and it may be presumed, that these two neighbouring nations were the first who pursued it, though they have since almost entirely abandoned it. They, however, instructed the Dutch in the art of the whale-fishery; and they, in their turn, have imparted it to the seamen of England. This latter country had much difficulty in establishing it; disastrous expeditions in its commencement almost annihilated it; but at length, aided by large *capitals*, and sustained by perseverance, England has in the end surpassed all its masters. The historical part is followed by very minute details of the different practices employed by the fishers. The author first discusses the state of the fishery in early ages, and the manner in which it was carried on. He afterwards relates the different alterations, or rather improvements, which it has undergone; and, lastly, he descri es it as it is now practised in the Polar Regions.

That part of the second volume, which comprehends the description of the whale-fishery, is intimately connected with what is said in the first volume on the precautions necessary in navigating among ice. In fact, the whales, pursued by the fishers, take refuge in the least accessible places; and one can only hope to meet with them by penetrating as near as possible to their retreat. The different species of ice require a different mode of navigating; and they also require a different procedure to discover the haunts of the whales, and to attack and to subdue them. This distinction marks two very different modes of fishing. The one is that practised at Spitzbergen and Greenland, where the whale is pursued in a wide sea, in which the ice covers a large extent of surface; the other is that of Davis' and Hudson's Straits, where, besides the extensive fields of ice, they encounter floating ice-islands of prodigious size and elevation. Systematic arrangement is conspicuous in those descriptions. After having discussed the most convenient size for ships destined to the whale-fishery, Captain Scoresby details the number of men suitable to each size, their necessary qualifications, and the most advantageous mode of distributing them, either in the boats, of which he fixes the number in proportion to the tonnage, or in the various occupations on board the ship. He does not fail to describe the utensils used in the fishery, and to ascertain the quantity necessary for a ship, according to her size.

These details are of the highest utility, because they communicate information only to be acquired by experience, and are followed by other topics of a nature to interest every class of readers; for the author next treats of the preparations which should be made for the pursuit of the whale: On the manner of attack he lays down rules applicable to all cases; and he follows up these by remarks on the precautions to be adopted when the animal takes refuge under fields of ice, of greater or less extent, or in *packs.* This second case is the most difficult of any; for the unconnected fragments of ice are in continual agitation, and liable to approach or recede; they sometimes offer a free passage at the moment least expected, while at other times, they not only block up that which before appeared open, but entirely surround the ships entangled among them, and sometimes come together with a force sufficient to crush the vessel by their immense pressure. Different instances, each applicable to particular cases which may occur, give a great interest to the preceding account, and contribute to throw much light on this subject.

What follows these descriptions is only interesting to commerce, such as the processes used in obtaining the products of the fishery, whether on board the ships, or on shore when the voyage is concluded, or in extracting the oil from the blubber, which was previously stowed away in casks. The author has adapted this subject to the general object of the whale-fishery, by giving an estimate of the produce of that carried on in the Greenland Seas, and he afterwards compares the relative profit of this fishery with that prosecuted in the Straits of Davis and Hudson.

The Appendix to the first volume contains a series of meteorological observations made in the Polar Regions during the months of April, May, and June, for twelve consecutive years, from 1807 to 1818 inclusive; this is followed by a table of results, giving the conclusions thence deduced on the mean temperature of the climates where these observations were made. The author has collected in the Appendix to the second volume every thing necessary to the completion of his subject, which could not be inserted in the body of his work; such as an abstract of the act of the English Parliament which imposes the present regulations on those engaged in the whale-fishery, either in regard to the conditions exacted from them by the State, or as relates to their conduct and their reciprocal rights, when great numbers of them are crowded in a small space, where a question may arise on the possession of a whale in the capture of which different fishers may have assisted. The same Appendix contains other details less interesting, but which it would be useless to enumerate in this place: their principal merit consisting in their rendering the work more complete, though they are not of a nature to enhance its interest.

The summing up of our opinion is, that the first volume of Captain Scoresby's work contains a great number of facts on the navigation of seas encumbered with ice, which we should in vain seek elsewhere; and the publication of a translation of this first volume would be very advantageous to navigation in general.

The second volume, dedicated entirely to a description of all the processes of the whale-fishery, and its probable advantages, would perhaps be a more important publication than the first, should there be any intention of reviving in France this species of industry. The general seaman might overlook this second volume, but those who dedicate themselves to the fishery must study the first volume; for it describes circumstances, of which the operations in the second are in fact only the consequences.

It is our opinion, that the translation of the work should not appear in detached portions: it is a perfect and compact *whole*, which ought to be respected. The translation and publication in question, do not appear of a nature to become an object of speculation. Not one person in France is engaged in the whale-fishery; and the work would only be in demand among a small number of the curious, who could not derive from it any immediate profit, while it would scarcely command the attention of those to whom it would be most advantageous.

But if the Government has any intention of reviving and encouraging the Whale-fishery, an art so long abandoned, that even traditional experience may be forgotten, the first step should be to publish the work of Captain Scoresby, where those inclined to speculate in this fishery, will find all the operations brought to perfection by the experience of the people who trade most extensively in its produce. Those who fit out ships have no necessity to search elsewhere for information on their construction and equipment, or the capital necessary for their adventure; and the Captains entrusted with the direction of the fishery, will here find all the practices and regulations necessary to insure success.

(Signed) ROSSILY & ROSSEL.

PARIS,
May 31. 1820.

Art. IX.—*Account of the Recent Magnetical Discoveries of Professor* Hansteen. Being the substance of a Letter from Professor Hansteen to M. Rumker, Director of the Nautical Academy of Hamburgh.

In two of the preceding Numbers of this Journal, (Vol. III. p. 124., and Vol. IV. p. 114.) we have laid before our readers an account of the very interesting inquiries of Professor Hansteen respecting the Magnetism of the Earth, as contained in his elaborate work, entitled, *Untersuchungen über den Magnetismus der Erde*, and published at Christiania in 1819.

Through the kindness of our learned correspondent M. Rumker, we have the pleasure of publishing an account of the recent magnetical discoveries of the same eminent natural philosopher, drawn up and transmitted by himself, and which have not yet appeared in any other work.

The observations on the diurnal variation of the needle given in our last Number, (Vol. IV. p. 199.), and transmitted to us by M. Rumker, were the result of a series of experiments which M. Hansteen made with an oscillating apparatus, the description and use of which forms the subject of his letter to M. Rumker.

D. B.

" The instrument which I use, is a small well hardened magnetic cylinder of steel *a b*, about $2\frac{3}{4}$ inches long and $\frac{3}{40}$th thick, suspended by a thread *cd*, (drawn from the cod of the silk-worm), in a square box, as shewn in Plate VI. Fig. 3. The cover MN of the box consists of three parts, of which the two outermost ones M, N, have glass windows, which may be drawn out. A hollow tube T, is screwed to the middle part P, in which the cylinder is suspended. The box rests on three screws, S, S, S, by which it is set horizontally. At the bottom of the box a divided arc *e f* is fixed, to read off the vibrations of the cylinder *a b*. This cylinder is drawn out of its magnetic meridian, by applying to the end of the box a little iron rod, which being held vertically, has in its lower part a north pole. On removing it, the cylinder begins to oscillate; and when the elongation is 20°, then the observation commences.

The times are marked by a chronometer at the instant of the beginning of the 1st, 10th, 20th, &c. oscillation, (or rather at the termination of the preceding one), continuing thus till 360 oscillations are completed, of which the last one vibrates within an arc of 2° only, large enough, however, to be distinctly observed. I now take the difference of the times marked at the first commencement and the beginning of the 300th vibration; also the difference between the 10th and 310th; likewise the difference between the 20th and 320th; and so on to the difference of the times marked at the beginning of the 60th and 360th. This gives seven different determinations of the duration of 300 vibrations each. If the arches through which the vibrations take place were not shortened by the opposition of the air, these durations would equal; but now the last duration is about $\frac{8}{10}''$ shorter than the first. I take therefore a mean of all the seven. After this I mark the time at every 6th duration; and thence I get a mean of 11 durations of 300 vibrations. The following example will explain the whole.

October 1. 1820.

Order of the Vibrations.	Instant of the Ceasing of the Vibrations.	Order of the Vibrations.	Instant of the Ceasing of the Vibrations.	Duration of 300 Vibrations.
	′ ″ ″		′ ″	
Ceasing of 0th vibr.	0 35,0 = 35,0	Ceasing of 300th vibr.	14 5,8 = 845,8	810,8
6	51,2 = 51,2	306	22,0 = 862,0	810,8
12	1 7,6 = 67,6	312	38,2 = 878,2	810,6
18	23,8 = 83,8	318	54,4 = 894,4	810,6
24	40,0 = 100,0	324	15 10,4 = 910,4	810,4
30	56,4 = 116,4	330	26,8 = 926,8	810,2
36	2 12,6 = 132,6	336	42,8 = 942,8	810,2
42	28,8 = 148,8	342	59,2 = 959,2	810,4
48	45,2 = 165,2	348	16 15,2 = 975,2	810,0
54	3 01,4 = 181,4	354	31,6 = 991,6	810,2
60	17,6 = 197,6	360	47,7 = 1007,7	810,1
			Mean,	810,41 *

Since the intensities are reciprocally as the squares of the durations of equal numbers of oscillations, I may assume any one of these durations as unity, and express the other ones in parts

* Mr Hansteen is not wrong $\frac{1}{10}''$ upon the mean of 11 durations.

thereof. Thus, I assumed for unity the intensity corresponding to the duration of 813″,6 (to 300 vibrations), taking this to be a *minimum*, because I found this intensity at an observation which I made whilst there was an aurora borealis.

Let I be the intensity, and T the duration corresponding to it.

Again, I′ another intensity, and T′ the duration corresponding.

Then, $I : I' = (T')^2 : T^2$; or $I = I' \left(\frac{T'}{T}\right)^2$; and as I have assumed $I' = 1$, and $T = 813'',6$, we have, $I = \left(\frac{813'',6}{T}\right)^2$; consequently, in the above example, $I = 1,0079$.

In this way I have calculated for each $\frac{1}{10}''$ a Table for the reduction of the mean durations, and corresponding intensities, of which the following is an abstract:

Mean Duration.	Intensity.	Mean Duration.	Intensity.	Mean Duration.	Intensity.	Mean Duration.	Intensity.
813,6	1,0000	811,0	1,0064	808	1,0139	805	1,0215
813,0	1,0015	810,0	1,0089	807	1,0164	804	1,0240
812,0	1,0039	809,0	1,0114	806	1,0189	803	1,0265

From the numerous observations which I have made in the course of the year, I have calculated the following Table, which will shew for each month a mean intensity corresponding to the stated hour of the day.

Hour.	8	10	12	2	4	6	9	10	Mean.
1819, Dec.	1,01931	1,01902	1,01915		1,01966	1,01929		1,01732	1,01912
1820, Mar.	1,01095	1,01010	1,01023	1,01136	1,01147	1,01113	1,01142	1,01063	1,01081

Hour of the day.	8 A. M.	10½	4 P. M.	7	10½	Mean.
1820, April,	1,00717	1,00625	1,00879	1,00966	1,00903	1,00818
May,	1,00582	1,00548	1,00849	1,00844	1,00740	1,00713
June,	1,00407	1,00397	1,00647	1,00700	1,00665	1,00563
July,	1,00277	1,00235	1,00461	1,00500	1,00548	1,00404
August,	1,00339	1,00335	1,00543	1,00570	1,00555	1,00468
September,	1,00560	1,00508	1,00708	1,00711	1,00715	1,00640
October,	1,00886	1,00800	1,00909	1,00953	1,00953	1,00900

From these observations, it follows, that

1. The magnetic intensity has a daily variation. The *minimum* falls between 10 and 11 in the forenoon, and the *maximum* between 4 and 5 in the afternoon.

2. The monthly mean intensity shews an annual variation, as may be seen better in the following Table, derived from my observations.

Month.	Mean Monthly		Greatest		Day.	Least		Day.	Difference,		Mean Daily Variation.
	Intensity.	Duration.	Intensity.	Duration.		Intensity.	Duration.		Intensity.	Duration.	
December,	1,01912	805,94″	1,0242	803,90″	14th Dec. 3 P. M.	1,0082	810,31″	16th Dec. 11 P. M.	0,0160	6,41″	0,00064
March,	1,01081	809,24	1,01745	806,58	5th Mar. 10 A. M.	1,0042	811,91	6th Mar. 10 P. M.	0,0132	5,33	0,00137
April,	1,00818	810,29	1,0151	807,53	27th April, 7 P. M.	1,0039	811,98	3d April, 10 A. M.	0,0112	4,45	0,00341
May,	1,00713	810,71	1,01615	807,10	2d May, 4 P. M.	1,0016	812,97	25th May, 10 P. M.	0,0145	5,87	0,00301
June,	1,00563	811,31	1,0088	810,05	14th June, 8 P. M.	0,9883	818,39	24th June, 11 P. M.	0,0205	8,34	0,00303
July,	1,00404	811,94	1,0104	809,39	21st July, 4 P. M.	0,9996	813,75	13th July, 10 A. M.	0,0108	4,36	0,00313
August,	1,00468	811,69	1,0078	810,45	29th Aug. 10 P. M.	1,00015	813,54	2d August, 10 A. M.	0,0071	3,09	0,00235
September,	1,00640	811,00	1,0111	809,15	4th Sept. 3 P. M.	1,0005	813,40	4th Sept. 8 A. M.	0,0106	4,27	0,00207
October,	1,00900	809,96	1,01205	808,74	25th Oct. 10 P. M.	1,00675	810,86	1st Octob. 10 A. M.	0,0053	2,92	0,00153

From this table it appears, that in the winter, near the perihelion, the intensity is considerably greater than what it is in the summer, near the aphelion.

In the two last columns but one, are contained the differences between the *maxima* and *minima* of intensity for each month, or *greatest monthly variation*. The last column contains the same difference in the course of a day, or *greatest daily variation*. The greatest monthly variation is a *maximum* in the months of December and June, about the time when the sun is in the tropics, or, perhaps more correctly, when the earth is in its perihelion or aphelion. It is a *minimum* near the equinoxes, or when the earth is at its mean distance from the sun. The greatest daily variation is least in the winter, and greatest in the summer. The greatest difference of the annual variation is 0,0359.

Suppose I call the horizontal part of the magnetic force = H, the whole force = F, the magnetic inclination n; then is $F = H \times \cos n$. Hence it follows, that H may be variable, although F be constant, allowing only the inclination to be variable. From a series of observations which I made with an inclinatorium (a dipping-needle) of Dollond's, I found, that the inclination during the summer is about 15′ greater than what it is in the winter, and in the forenoon about 4′ or 5′ greater than what it is in the afternoon; which agrees perfectly well with the former observations.

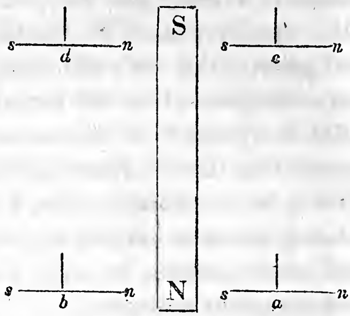
I next made an experiment like that of October 1. continued without interruption from noon till noon, during an aurora borealis, which clearly proves the influence of this phenomenon of weakening the magnetic force, and consequently shews the relation between magnetism and electricity." Similar experiments were made by the Professor, which prove that the magnetic intensity is always weakened when the moon crosses the equator.

In the course of last year, Professor Hansteen spent a few days in Copenhagen, and resided in the Round Tower. Here he repeated his experiments, and found, to his surprise, that the duration of 300 vibrations was not less than 836″,57, although he found it in a garden below only 779. Now, from Bugge's *Observationes Astronomicæ*, it is known, that the walls of this tower, which is 126 feet high, are 4 feet 4 inches thick; and another hollow cylinder of 4 feet 6 inches inner diameter is contained within it, round which a walk of seven turnings leads to the top.

After several experiments below, which all gave 787″ for the mean duration, Hansteen returned to the tower, and found in the highest part of the tower the duration of 300 oscillations = 842″,37

1 turning below, - - -	836,57
2 turnings lower, got - - -	837,30
$1\frac{1}{2}$ turning lower, - - -	834,43
2 turnings lower, - - -	804,07
Down below, within doors, - -	813,00

This attracted the attention of Professor Hansteen, and, after having further extended his observations on this point, he obtained the general result, that at the foot N of any vertical object SN, the cylinder oscillates quicker in *a*, to the north end thereof, and slower in *b* to the southward thereof; but on the contrary, at the upper part S, it oscillates quicker on the south side at *d*, and slower on the north side at *c*. Hence, he draws the conclusion, that every vertical object, of whatever material it is composed, has a magnetic *south pole* above, and a *north pole* below.



Art. X.—*On the Ancient Volcanoes of Auvergne.* By Charles Daubeny, M. D. M. G. S. and Fellow of Magdelane College, Oxford. In a Letter to Professor Jameson.

Dear Sir,

In my former communication, I took notice of the Volcanic Rocks found in the immediate neighbourhood of Clermont, all of which, with the exception of a few mountain *caps*, composed of basalt, which were mentioned in the close of my letter, appeared to me of post-diluvian origin. I shall next proceed to another class of rocks, which, although probably belonging to the same general head, seems, nevertheless, to present several important differences.

The Mont d'Or range of Hills, which is the principal subject of the present paper, must, I believe, be referred exclusively to the class of Ancient Volcanoes, inasmuch as they are found, like the rocks on which they lie, at equal levels, on either side of the valleys which intersect them; and, therefore, if we suppose that they were once in a state of fluidity, a point which I hope afterwards to be able to establish, evidently prior to the formation of the latter.

These are the rocks, which appear to me to supply the connecting link between what is called the Newest Flœtz-Trap Formation of Werner, and the products of existing volcanoes; for those who have taken the trouble of perusing my former letter, will perceive that the rocks therein described differ in so many important points from the former, that we should hardly be justified in arguing from the one to the other. Should it, however, appear that there is reason for concluding the chain of Mount d'Or to be of volcanic origin, I know not how we can help extending the same inferences to many of the basalts of our own and other countries, to which it seems to present such striking and numerous analogies.

Two classes of volcanic rocks compose the chain of Mount d'Or. On the summit of the great Table Land of which it consists, is a basaltic formation, associated with a sort of trap tuff or breccia *, and other rocks.

Underneath this is a porphyritic felspar-rock seen exposed in the valleys, which has generally obtained the name of *Trachyte.*

Below all is seen the granite, which seems to constitute the original substratum throughout the whole of this Province; the volcanic, and even the fresh water formation, hardly deserving to be considered as parts of the crust of the earth, but being rather in some sense extraneous to its composition †.

We shall consider these rocks in succession, beginning with the highest in the series.

1. The Basaltic Formation of Mont d'Or comprises several rocks, differing from each other much in appearance and external characters.

The rock which has induced me to give this name to the whole, is a compact and sonorous basalt, generally containing

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* Although in general very averse to alterations in nomenclature, I cannot help agreeing with Dr MacCulloch in the propriety of substituting the term "Trap-Breccia" for Trap-tuff, as the latter word is objectionable, not merely as inexpressive of the true character of the rock, but as conveying an erroneous idea of it.

† M. d'Aubuisson, in his late work on Geognosy, not unaptly compares the Primitive Rocks to the skeleton of an animal, the Secondary to the muscular parts, and the Volcanic to the parasitical animals that are produced upon its surface.

disseminated crystals of hornblende, having frequently an acicular form, and sometimes a few of olivine. Associated with it is a vesicular rock, to which the name of Lava may not improperly be given, since the cavities which it contains possess no appearance of having once been *filled*, like those in the amygdaloids of basaltic countries, and its general aspect obliges us to refer it to the same class with the undisputed products of volcanoes now in activity. We meet also with scoriæ, either in detached fragments, or with portions of compact trap, the whole cemented together by iron-clay, so as to constitute a species of volcanic tuff. I found the order of superposition on a hill which I examined near Lake Gery, a few miles from the village called "Les Bains de Mount d'Or," to be as follows:

On the summit a thin bed of scoriæ. Underneath, a tuff, containing fragments of the more compact, united with the vesicular variety of lava, but in some places in a state of such extreme division, that the whole might be mistaken at a distance for red sandstone. Beneath all was a very compact and crystalline basalt, made up of a confused assemblage of these acicular crystals of hornblende, crossing each other in all directions, intermixed with felspar.

It would seem that this is the general order of superposition; and the pressure of the vesicular matter above may possibly have contributed to give to the rock underneath the hardness and consistency which it is found to possess.

Thus, we may observe in many of the recent volcanic products near Clermont, that the masses which lie underneath are less vesicular than those near the surface, although I have noticed in my former communication one fact which seems to militate against the universality of this remark. It is also true, that I have found basalt among the mountains of Auvergne, uncovered by any more porous rock; but is it not probable, that the same causes which excavated the valleys, and removed all traces of the craters, which we must suppose to have once existed, should have in these instances swept away the upper strata, which, from their looser and more vesicular structure, were less able to oppose resistance? May not this account for the occurrence of clinkstone, the least decomposable of trap-rocks, chiefly on the summit of hills; for this position seems hardly referable to any law in the original formation of the rocks of which it forms a part, since we now and then meet with it underneath other rocks *.

From the description we have given, it will be easily understood, that the subjacent rock, the trachyte, is only seen exposed on the sides and in the bottom of the valleys, the great and elevated Table Land, which composes the range of Mont d'Or, and extends with little interruption into Cantal, having its upper strata composed of basalt, and the other rocks associated with it; the scorified matter appearing to diminish in quantity, in proportion as we recede from the loftiest part of the chain. That these strata are all volcanic, is pretty convincingly proved by the vesicular structure of those which lie uppermost; for it seems impossible to assign a different origin to the basalt, and to the scorified matter superimposed *; yet it is difficult to form an opinion in what direction this immense stream of lava can have flown, or from what point it could have been ejected. I noticed, indeed, one or two lakes, which gave me much the idea of their having once been craters, the Lake Servieres in particular, to the north of the village of Les Bains, the sides of which are composed like the Puy Pariou, near Clermont, of vesicular lava, and its form equally round and regular. Near it is a little hillock, not exceeding 50 feet in height, of a conical shape, consisting chiefly of the same materials.

Yet, if this was a crater, the situation of the country must have greatly altered since the period at which it was in activity, its height, although absolutely great, being relatively to that of the rocks surrounding it, very inconsiderable. It lies, indeed, in the midst of this great Table Land, if it may be so termed, little, if at all, elevated above the general level.

2. The Trachytic Formation is essentially composed of crystals of glassy felspar, imbedded in a base of the same materials. Its fracture is more commonly rough and earthy, but is not unfrequently compact. In the latter state it is, that augite, mica,

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* As in the Isle of Lamlash underneath sandstone.

† M. d'Aubuisson has remarked at Pradelles, near Clermont, basalt incumbent on a bed of scoria.

and hornblende, are most frequently found imbedded, whilst it is the former variety which contains the finest and most regular crystals of glassy felspar. It passes sometimes into pitchstone porphyry as at the Vallée d'Enfer, at others into a kind of hornstone porphyry, as on the road to Murat, both near the village where the baths are situated. It is frequently coloured red by iron, and sometimes incloses flattened balls of clay-ironstone. In its fissures and cavities are also found plates of specular iron-ore, a substance which we have noticed as occurring among the recent volcanoes near Clermont, and particularly at the Puy de Dôme.

The trachytic formation has also associated with it beds of tuff, containing portions of scoriaceous and vesicular lava, as well as of basalt, united generally by a felspar basis. To this probably must be referred those singular beds occasionally seen interstratified with the trachyte, which consist of an apparently homogeneous rock, bearing a resemblance to tripoli, possessing a rough earthy feel, and slaty fracture, generally grey, but sometimes of an ochreous yellow colour, from the intermixture of oxide of iron. M. D'Aubuisson, in his late work on Geognosy, supposes, that these beds as well as the tuff, owe their origin to the disintegration of the trachyte, and the subsequent agglutination of the finely divided fragments into an uniform mass. He states, that M. Beudant has found, that the Opals of Hungary lie in a matrix constituted of this *regenerated* description of rock; and some observations I have recorded in a paper of mine, which was lately read before the Geological Society, may contribute to render this fact somewhat more credible. To this formation of tuff we may probably also refer those fragments of a breccia, containing sulphur and alumstone, found in the Gorge d'Enfer, near the village of the Baths, in the bed of the River Dordogne, which takes its rise in the mountain above. Of this rock M. Cordier has published, in the "Annales des Mines," a description as well as an analysis, from both which he infers that it is analogous to the alumstone of Tolfa, like which it yields, on exposure to heat and moisture, numerous capillary crystals of alum. It has never been found *in situ*, but it seems probable, that if the middle regions of the Pic de Sancy, above the spot to which it has been brought by the torrents, could be brought by the torrents, could be fully explored, the beds of tuff which are there met with might be found to contain it.

The following is the result of Cordier's analysis, together with that of the Tolfa aluminite by Klaproth and Vauquelin; the former at least has never, I believe, found its way into any English scientific Journal.

Alumstone of Tolfa.

	Vauquelin.	*Klaproth.*
Alumine,	43.92	19.50
Silex,	24.00	56.50
Potash,	3.08	4.00
Sulphuric acid,	25.00	16.50
Water,	4.00	3.00
Loss,	0.00	1.00
	100.00	100.00

Alumstone of Mont d'Or.

	Cordier.
Alumine,	31.80
Silex,	28.40
Potash,	5.79
Sulphuric acid,	27.05
Water,	3.72
Protoxide of Iron,	1.44
Loss,	1.80
	100.00

Near the village of the Baths, the trachyte is traversed by several dikes of vesicular lava, which are connected above with the basaltic formation. They occur in a deep ravine, which appears to have been made in the side of the valley wherein the Baths are situated, by a waterfall, which is commonly called the "Grande Cascade de Mont d'Or," although at the time I visited it, its magnitude did not seem to entitle it to that distinction. Of these dikes, some might be supposed to have been forced up from below, since their terminations are not visible, but two others were distinctly seen ending in the trachyte. It might be said, indeed, that the apparent termination of the dikes in this instance proves nothing, as it is possible the vein might have been continued in that portion of the rock which has been removed by the excavation of the valley; and though the vertical direction of the vein, with no apparent inclination outwards, does not favour that idea, I might nevertheless have admitted it, had there been any evidence of dislocation or hardening in the rock which is traversed by it. The absence, however, of any alteration that I perceived, either in the position or in the external characters of that portion of the trachyte which lies contiguous to the veins, leads me to suppose that the latter has been formed from above out of the basaltic lava, which might have insinuated itself, while in a liquid state, into cracks or fissures in the trachyte below it, and not that they were the rents through which the basalt was originally forced into the spot which it now occupies.

Respecting the nature and origin of the trachytic formation, many questions arise, which it will be found very difficult to solve. That it has been produced, or at least affected by the agency of heat, appears evident from the scoriæ and pumice with which it is found associated, as well as from its analogy with the undisputed lavas of the Lipari Islands. But the *nature* of the materials from which it has been formed, and the manner by which the action of fire has reduced these materials into the state in which we now find them, is no less obscure than the explanation of the process which has produced an analogous rock found among the recent volcanoes near Clermont, namely, the Domite of the Puy de Dôme. Notwithstanding certain differences in appearance existing between these two rocks, the general resemblance is such, that we can hardly hesitate to refer both to the same formation, and admit that the trachyte is to the ancient lavas what the domite is to the modern. Both indeed appear to be products of the same mud volcanoes, which have had such extensive operation in the New World, and in the Old have produced the lavas of the Lipari Islands, and a few of those in Italy.

At the same time, it must be confessed, that certain varieties of trachyte bear the most striking resemblance to some of the porphyries in Scotland, which are by no means generally admitted to be volcanic.

If the clinkstone of Mont d'Or should, as M. Daubuisson supposes, be a modification of trachyte, I know not how we are to help extending the same inference to that of North Berwick and Trapraine Law in East Lothian, nor can two rocks brought from distant parts of the globe resemble each other more closely than do certain varieties of the trachyte of Mont d'Or, and the claystone-porphyry of Drumodoon in the Isle of Arran. It is thus that we are brought to acknowledge the insufficiency of our present data to determine many of the great questions of geology, and that a little more extensive information makes us doubt the truth of those opinions which we had previously imagined to be the best established. Before, however, I quit this subject, I cannot help remarking the analogy which exists generally between the rocks of Auvergne and those of the trap formation in the North of Ireland. The basalt of the latter country can scarcely be distinguished in external characters from that of Mont d'Or, or at least differs from it much less than one variety of that rock found in the same formation differs from another. It is indeed distinguished by the total absence of scorified matter; for I conceive it to be beyond question, that the cinders found close to the bed of brown coal, which lies in the midst of the basalt immediately above the Causeway, are owing to some artificial fire; and it differs likewise in the greater abundance of dikes cutting through, and hardening in their vicinity the rocks on which the basaltic deposit in Ireland is incumbent, and the regular columnar arrangement which it more frequently affects. But of these differences you will not be disposed to lay much stress on any except the first, and the natural inference from it seems to be, that the basalt of the Giant's Causeway has been formed at the bottom of the then existing ocean, whereas in the case of that of Mont d'Or, the necessary pressure was supplied by the masses of scorified and cellular matter above it,—a portion of which, as I have already stated, may since have been removed by the action of the elements, leaving the subjacent basalt partially uncovered. The rarer occurrence of dikes and of columnar concretions in the basalt of the Mont d'Or than in that of Antrim, cannot be considered as of much weight towards determining the present question, especially as instances are not wanting, even in the former country, of columnar basalt, almost as perfect and regular as we meet with elsewhere *. Indeed, I am inclined to think, that the superior symmetry and greater frequency of the basaltic columns in the north of Ireland, is attributable rather to the action of water along such an extent of coast, in developing in a gradual manner the latent structure of the mass, than to any original peculiarity in its

* In the Vivarais we meet with numerous instances of the most regularly columnar basalt, which has evidently flowed from volcanoes, since the excavation of the present valleys. See *Faujas St Fond sur les Volcans des Vivarais.*

composition or the manner of its formation. At a cascade near the village of the Baths of Mont d'Or, I observed some very regular basaltic columns just where the escarpment of the rock was touched by the falling spray, and nowhere else,—an observation which, with some others tending to the same point, I communicated to the Geological Society, in a paper read before them last summer.

The analogy also of the trachytic formation with the porphyry of Sandy Brae in the same country, although it may not hold good in all points, is nevertheless such as to lead to many interesting conclusions. Both present a correspondence in the crystals of glassy felspar which enter so largely into their composition; both pass into pitchstone-porphyry, and the trachyte of Cantal even contains, like that of Sandy Brae, imbedded masses of opal.

They differ, indeed, inasmuch as the Irish porphyry abounds in quartz,—a mineral so rare in the trachyte of France, that M. Daubuisson says it is found only in one spot of Cantal; but it should be recollected that the absence of quartz may be considered an accidental circumstance, since M. Beudant has discovered varieties which contain it abundantly in that porphyritic formation of Hungary, which, from its general characters and relations, he ranks with the trachytes of Auvergne. Whether these varieties approach more nearly to the Sandy Brae porphyry, it will be for future travellers to determine *; but, even according to the present state of our knowledge, we cannot help regarding the association of claystone-porphyry, containing pitchstones and opal, with basalt, as tending to bring the rocks of the Giant's Causeway a step nearer the volcanic formations of Auvergne.

3. The third or lowest of the formations found at Mont d'Or is the Granite, which, concealed throughout the greater

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* Since writing the above, I find, from the valuable work of Dr Boué on the Geology of Scotland, recently published, that these varieties do in reality approach very near to the porphyry of Drumodoon in the Isle of Arran, (*Vide* p. 295.) which he justly considers analogous to the rock of Sandy Brae in Ireland, *Vide* p. 384.) I may therefore regard my conjecture as to the resemblance between the quartzous trachyte of Hungary and the Irish porphyry as confirmed.

part of that range by the volcanic rocks superimposed, crops out near the western extremity of the valley in which the Baths are situated, at the village of Bourbeuli. It is small-granular, consisting of a white disintegrated felspar, white quartz and black mica; sometimes it is compact, but at others it has passed into the state of kaolin. As there is nothing remarkable in its appearance, I should hardly have thought it necessary to notice it, except from the circumstance that the trachyte superimposed has been supposed to be derived from it; and if I have succeeded in rendering it probable that the rock of the Puy de Dôme, Puy de Chopine, &c. mentioned in my former letter, are granite, in various states of alteration, the same will necessarily follow with regard to the trachyte. The singular difference, indeed, between the composition of granite and trachyte, the abundance of quartz in the one, the almost total absence of it in the other, may appear to some hardly reconcilable with this opinion; but as, I have remarked in my former letter, the silica of the quartz may, in the new compound resulting from the fusion of the granite, have gone towards the formation of the felspar,—a mineral which, according to the best analyses, contains above 60 *per cent.* of the earth in question; and if we consider that the mica, which occurs in much smaller proportion in the trachyte than it does in granite, falls short of the felspar in the quantity of silex which it contains almost as much as the quartz exceeds it,—our difficulty seems in a great measure removed, as the absolute quantity of silica in either rock does not perhaps materially differ.

In describing the rocks found at Mont d'Or, I have said almost all that appears necessary respecting the trachyte of Auvergne, for that of Cantal is distinguished chiefly by its more compact form, and by the rarer occurrence in it of scorified matter. The highest hills in Cantal are mostly capped with porphyry-slate or *phonolite*, a substance found also at Mont d'Or, capping the trachyte at the rocks Sanadoire and Thuiliere. The clinkstone in both instances is considered by Daubuisson as a modification of the trachyte, but to me it did not appear to pass into that rock; nor does this conclusion seem warranted by its appearance, remarkably distinguished as it is even at a distance, by its more harsh and rugged outline, derived from the very indestructible nature of the materials which compose it. Hence the hills in Cantal are usually covered towards their summits, owing to the presence of this rock, with massive fragments of stone, of a greyish colour and great hardness, whereas the trachyte underneath decomposes in a more rapid and uniform manner. Nor can there be a greater contrast than between the luxuriance of some of the valleys, as that of Teyzac, in which the substratum is of trachyte, and the extreme barrenness of the higher parts, which are composed of *phonolite.* The porphyry-slate, too, found on the summit of the Plomb de Cantal, the highest mountain in that district, bears a much closer analogy to basalt than to trachyte; and the circumstance of the clinkstone occupying the same relative position in Cantal which the basalt does at Mont d'Or, would lead us to infer that it is more allied to the latter formation than to trachyte. We have already alluded to the tuff, which, at Mont d'Or, is found associated with trachyte. A similar rock occurs in much greater abundance throughout Cantal; it is there remarkably distinguished by the grotesque appearances which it assumes, presenting to the eye a range of mural precipices, broken into a number of fantastic shapes,—a circumstance very characteristic of rocks of this description, both here and in the neighbourhood of the Puy en Velay.

It is only necessary to refer the reader to M. Faujas St Fond's description of the Rock of St Michael, near the latter town, which stands isolated in the midst of the valley, and from the small proportion which its diameter bears to its height, more resembles some work of art than a production, or rather a relic of nature. This and a projecting rock, almost equally extraordinary in its appearance, which is found near the same spot, and goes by the name of "Le Rocher Rouge," from the red colour which its surface presents from decomposition, M. Faujas seems to suppose to have been projected by some convulsion of nature from the bowels of the earth; and he even refers in the latter instance to an appearance of dislocation in the granite which encircles it, as giving countenance to this opinion.

This circumstance ought to render us cautious in deciding on the reality of those alterations on the position of strata which philosophers are so fond of seizing upon as evidence of volcanic action. I examined the spot myself, and was, I confess, struck with the apparently broken condition of the contiguous granite, and yet it seems, upon cool consideration, to be physically impossible that a mass of rock of this shape and size should have been propelled from the earth, and should have remained for ages protruding, in the position in which we now find it. I need only appeal to those who have visited the spot, or even to such as have examined the plates of M. Faujas, in his large work on the Vivarais, in support of this assertion.

Another instance of apparent change in the stratification of a rock, as connected with a dike, occurred to me in the course of my tour in Cantal, which, considering all the circumstances, it might be rather bold to refer to the operation of a force acting from below upwards. It occurs about a league from the town of Aurillac, on the road to Murat, in the fresh water formation which prevails over much of that part of Cantal, very different, indeed, from that around Paris, if we regard its external characters, but identified with it by the shells which it contains. This calcareous rock is traversed obliquely by a dike of a kind of amygdaloidal wacke, containing in its cavities much green earth, and inclosing fragments of various trap-rocks, as well as of the limestone which it cuts through, and of the flinty nodules which the latter contains. Just above the stratification of the calcareous rock, it is remarkably changed from an horizontal to a vertical direction; yet, on the other hand, we observe organic remains in the limestone, even where it is in immediate contact with the dike, and the latter nowise affected in point of hardness or other circumstances. Nor does the aspect of the dike itself, any more than that of the rock which contains it, favour the idea, which its altered stratification naturally suggests.

In Cantal, the tuff is best displayed near the village of Teyzac, on the road from Aurillac to Murat, where the traveller should establish his head-quarters at a very comfortable inn which the place affords, as a convenient central position, from whence he may examine the Plomb de Cantal, and most of the interesting country in the Department. The tuff there, is placed between two beds of trachyte, being found rather less than half way on either side of the hills which bound the valley, whilst the summit and the base alike consist of trachyte. It dips gradually to the east; so that about half a league from Teyzac, on the road to Murat, it reaches the level of the road. Different as the tuff appears from the trachyte which it accompanies, it will be found on examination, that the fragments of which it consists are cemented always by a basis of the latter rock, and that a passage from the one to the other proceeds by imperceptible gradations. The fragments are in general a trachyte of a more compact character than the paste which cements it, but we also find basalt and cellular lava intermixed; and I remarked beds or veins of the same description of stone so much resembling tripoli, which I have already noticed as occurring at Mont d'Or. A little beyond Teyzac, near Vic en Carladez, I saw an instance of an incurvation of its strata, like what happens in the zones of an agate; the layers of this rock being contorted uniformly one to the other in the middle of the body of the tuff, in a manner which reminded me of the natural arch of clay-porphyry which I observed in Arran, and which may now be seen figured in the Plates to Dr MacCulloch's work on the Western Islands; and of a similar conformation of the sandstone at a village near Edinburgh.

It is curious that the tuff sometimes contains perfectly isolated portions of a quartzy sandstone, which seem to bear no analogy whatever to the other constituents of the rock; and at Salers, where the fragments are in general so minute, that the whole has much the appearance of a ferruginous sandstone, impressions of leaves and branches of trees, often in no respect mineralized, but reduced to an impalpable powder, by the ordinary process of decay, are found contained in it. In other cases, where the tree has wholly decayed, the hollow which it occupied in the midst of the tuff still remains to indicate its having existed. These circumstances tend, in a still greater degree, to identify the Trachyte Formation of Auvergne with the ordinary products of mud volcanoes.

And here I may conclude what I have to say of the volcanic rocks found in Auvergne, a country which deserves to be studied by all who are anxious to arrive at an unbiassed decision respecting the origin of a class of rocks which occupy no inconsiderable portion of the earth's surface. We are here enabled, as it were, to observe a series of experiments which Nature herself has instituted respecting the action of heat on solid bodies under different circumstances, the results of which, it is presumed, are more likely to be conclusive than any which can be conducted in our laboratories, allowing every credit to the talent of the individuals who conducted them; and even admitting their importance with reference to the point in question, as corroboratory of what we may have observed on the great scale in countries like Auvergne. I am far, indeed, from having the presumption to suppose, that the facts recorded in this and the former letter, are sufficient to decide the question; but my purpose will be answered, should it contribute to excite some more accurate and acute observer to go over the same ground that I have done, convinced, that if ever the origin of the trap-rocks in our own and other countries be fully cleared up, it will be owing in a great measure to a due examination of the analogous formations in Mont d'Or and in Cantal.

Before, however, I bring this letter to a close, there is one observation which may be hazarded, without entering too much into theory, inasmuch as it seems immediately deducible, either from the foregoing facts, or from others which, I apprehend, will be pretty generally admitted. As there appears an almost uninterrupted transition from lava to basalt, from basalt into greenstone and sienite, from sienite into granite, and from granite into sandstone; and since it is evident, that the *two extremes* in this apparently connected series *must* have originated from opposite causes, we are brought at length to admit, that similarity of character in rocks is not sufficient to establish identity of origin; and that the structure, position and connexions of a rock on the great scale with those contiguous, must be taken into the account in each particular case, before we decide, whether the formation in question ought to be ranked among the products of Fire or Water. There seems at least to be the same resemblance between certain varieties of sienite and greenstone, as any which can subsist between the trap-rocks in the north of Ireland, and those which occur interstratified with sandstone and calcareous beds on the coast of Fife, near Edinburgh. Yet, how many geologists scruple to admit the igneous origin of the *former*, from considering its connexion with granite, who, nevertheless, feel themselves compelled to admit the trap-rocks above mentioned as volcanic, from their analogy with those of the Giant's Causeway! Even such as, with Dr MacCulloch, include granite among the products of Fire, or, even with my ingenious friend Dr Boué, broadly assert that all rocks, at least as far down as sandstone, which are not of mechanical origin, must be referred to this agent, cannot but be puzzled at the resemblance subsisting between certain varieties of granite and of the old red sandstone.

Since, therefore, it seems to follow, that Fire and Water, although such opposite agents, have, in some instances, produced effects nearly, if not altogether identical, I do not see that the geologist who returns from Auvergne, persuaded that great part at least of what has been called the Newest Flœtz-Trap Formation of Werner is of volcanic origin, ought to be accused of inconsistency, if he still hesitates as to the real origin of those rocks, which, if, in their external characters, they approach to the latter, would seem, nevertheless, from their repeated alternations with sandstone, and other strata of a similar description, to be of Neptunian origin themselves *.

I had intended adding some remarks on the Fresh Water Formation of Auvergne; but as the present memoir has already

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* Those of your readers who may recollect what I said in my former letter respecting the Puy Marmont, where trap-rocks which were assumed to be of igneous origin are described as alternating with a fresh-water limestone, may object to the present conclusion as inconsistent with the former statement. I have nowhere, however, denied the possibility of an alternation of volcanic rocks with the products of aqueous deposition, the actual occurrence of which is indeed sufficiently established, by the observations of those who have travelled in countries admitted to be volcanic; but, on the other hand, it will, I think, be allowed that the *probability* of such an accident diminishes in the direct ratio of the *number* of such alternations, and, therefore, that those who do not go so far as to consider the sienite and greenstone rocks of Primitive Districts as volcanic, and consequently see nothing in the structure and composition of hornblende or augite rocks in general, which *stamps* them as the Products of Fire, will regard such a succession of beds as that which meets our eye on the Fife coast, from Kinghorn to Kirkcaldy, as more probably referable to one *agent*, and that water, than to the alternate influence of *two opposite* forces, repeatedly giving way, as if by consent, one to the other.

swelled to such a size as I fear must have exhausted the patience of many of your readers, must subscribe myself,

Very truly yours, C. DAUBENY.

MAGD. COLL. OXFORD, *Jan.* 16. 1821.

ART. XI.—*Observations on the Resistance of Fluids.* By WILLIAM WATTS, Esq. Communicated by the Author.

THE effect of the deep immersion of bodies in water, still remains a contested point in the theory of the resistance of Fluids; and many persons are of opinion, that the resistance increases with the depth, although the experiments of Sir Isaac Newton, made with small globes formed of wax, having lead inclosed in them, and made so light as to weigh only a few grains in water, in order that they might descend very slowly in this fluid, *seem* to prove that the resistance is *equal in every part;* for these globes having been let fall *in water*, descended in the same manner as they would have descended in a fluid in which the resistance was every where equal, though, when they were near the bottom of the vessel, the compression was many times greater than when they were near the top.

This supposed increase of resistance at greater depths, is *even* assumed as a *principle* by *Mr Gordon*, in his Theory of Naval Architecture; but the grounds of this assumption do not appear to be satisfactorily explained; and this is not to be wondered at, if we consider that a competent knowledge of the mutual actions of fluids on each other, is accessible only to those who are intimately acquainted with all the refinements of the modern analysis, and that, without this key, there is no admittance into this department of the physico-mathematical sciences.

These observations, however, do not apply to the investigation of DON GEORGE JUAN D'ULLOA, who, in his "*Examine Maritimo*," has attempted to consider the subject in a scientific manner, and has given some important experiments, similar to those adduced by M. Bouger, in his "*Manœuvre des Vaisseaux*," but leading to very different conclusions.

According to this author, the resistance is in the sub-duplicate ratio of the depth of immersion below the surface of the water, and the simple ratio of the velocity of the resisted surface, *jointly*; and my object in drawing up this paper, is to attempt to prove, that there is nothing in this proposition inconsistent with the generally received principle in experimental philosophy, that the resistances are, very nearly, in the duplicate ratio of the velocities; and, at the same time, to answer some objections which have been urged against it by the writer of the article "Resistance" *of Fluids* in the Encyclopædia Britannica.

In making this attempt, I have adopted the principles employed in the investigation of this problem by d'Ulloa, or rather by M. Prony, in his "*Architecture Hydraulique*," section 868. &c.; but in order to render the investigation more clear and obvious to readers in general, I have taken the liberty to deviate from his manner of treating it, because I am most decidedly unfriendly to the trite form of modern solutions; and as I consider the investigation, as given by M. Prony, to be defective, inasmuch as it appears, to me at least, to be left in an unfinished state, I have attempted to complete it, in the best manner I am able.

Let o be an elementary orifice, or portion of the surface of the side of a vessel filled with water; call the area of this small surface b, and let h be its depth below the horizontal surface of the fluid. Let p be the actual pressure exerted on the surface b, ϱ the density of the fluid, and g the accelerating force of gravity = the velocity acquired by a heavy body, during the first second of its fall; then, by the principles of Hydrostatics, the pressure on the orifice o, when the fluid escapes into a vacuum, will be

$$p = g\varrho bh + g\varrho bh'.$$

This value of p consists of the pressure $g\varrho bh'$, which the horizontal surface of the fluid sustains; and also of the pressure $g\varrho bh$, which represents the weight of a volume of the fluid equal to bh. If, therefore, we neglect the first part $g\varrho bh$, it is evident, that the pressure which the surface b sustains at the depth h below the horizontal surface of the fluid, is equal to the weight of a prism of the fluid, whose base is equal to b, and whose height is equal to h: thus, when the fluid escapes into air, the pressure at the orifice o, will be equal to $g\varrho bh$ only; because the pressure $g\varrho bh'$, which is transmitted to the surface b, by the intervention of the different strata of the fluid, is balanced by an equal and opposite pressure of the atmosphere acting without the orifice o. In this case, therefore, we have

$$p = g\varrho bh \ldots\ldots (1).$$

The same reasoning holds good, when we suppose that the small surface o is immersed to the depth h below the upper surface of a stagnant fluid, and moved through it with the velocity v; for when the velocity is very great, so that a perfect vacuum is left behind the small surface o, we shall have

$$p = g\varrho bh + g\varrho bh';$$

but when the fluid does not escape into a perfect vacuum, or any thing like it, but into a mixture of air and water, the pressure at the depth h below the upper surface will be, nearly,

$$p = g\varrho bh, \text{ as before.}$$

I have been more particular on this head than I should otherwise have been, with a view to meet an objection that has been advanced against this part of the subject.

Now, it is well known, that when the pressure is the same at the upper surface of the fluid and at the orifice o, or at the anterior and posterior surfaces of the base b, the water will flow out with the velocity $u = \sqrt{2gh}$; whence we deduce $u^2 = 2gh$, and $h = \frac{u^2}{2g}$.

If we substitute this value of h in the equation (1), we shall have

$$p = g\varrho b \cdot \frac{u^2}{2g} = \tfrac{1}{2}\varrho bu^2.$$

Let us now suppose the elementary surface o to move with the velocity v; then the fluid would meet it either with the velocity $u + v$, or $u - v$, according as it moves in the direction opposite to that of the effluent fluid; or in the same direction with it: and, by substituting $(u \pm v)^2$ instead of u in the preceding equation, we shall obtain

$$p = \tfrac{1}{2}\varrho b\,(u \pm v)^2 = \tfrac{1}{2}\varrho b\,.\,(\sqrt{2gh} \pm v)^2:$$

but $p = gm$, where m represents the mass of matter actuated by the force of gravity g;

$$\text{Therefore, } m = \varrho b\left(\sqrt{h} \pm \frac{v}{\sqrt{2g}}\right)^2.$$

If, therefore, the small surface o be immersed to the depth h below the upper surface of the water, and moved through it with the velocity v, it will sustain on the one side the *dead pressure* $\varrho b\left(\sqrt{h} + \frac{v}{\sqrt{2g}}\right)^2$; and on the other *that* of

$\varrho b\left(\sqrt{h} - \frac{v}{\sqrt{2g}}\right)^2$: the difference of these two *dead pressures* is,

$$dp = 4\varrho b\sqrt{h} \times \frac{v}{\sqrt{2g}} \ldots\ldots\ldots (2).$$

This equation exhibits the *ultimate sensible* pressure, or resistance; or, which is all one, the element of the quantity of motion communicated to the fluid in an unit of time; and therefore, $4\varrho b\,v\sqrt{\left(\frac{h}{2g}\right)}\,.\,dt$, will be the differential of the quantity of motion communicated to the fluid during the instant $d\,t$.

Let M, therefore, be the mass of the body which the surface b presents to the direct impulse of the fluid, and dv the *instantaneous* diminution of the velocity v, caused by the resistance of the fluid, then, because the impulse of the resisting surface causes it to lose a quantity of motion equal to that which it communicates, we shall have the equation,

$$\mathrm{M}\,d\,v = 4\varrho bv \times \sqrt{\left(\frac{h}{2g}\right)}\,.\,dt,$$

whence we conclude that the force opposed to the resistance, is

$$\frac{d\,v}{d\,t} = \frac{4\varrho bv}{\mathrm{M}} \times \sqrt{\left(\frac{h}{2g}\right)} = \mathrm{R} \ldots\ldots\ldots (3).$$

That is to say, that *the resistance is in the sub-duplicate ratio of the depth of immersion, and the simple ratio of the velocity of the resisted surface, jointly.*

And since we are at liberty to suppose $\sqrt{h} = \frac{v}{\sqrt{2g}}$, we shall have $R = \frac{2\varrho b}{gM} \times v^2$.

Thus, it appears, that *the resistance* R *is in the duplicate ratio of the velocity, as it ought to be;* and therefore, the validity of the proposition under consideration is completely established.

The value of R in the two preceding equations, may be reduced to known measures by means of the equation $v = \sqrt{2gh}$; for, by substituting this value of v in the equation (3), it becomes

$$R = \frac{4\varrho b . \sqrt{2gh}}{M} \times \frac{\sqrt{h}}{\sqrt{2g}} = \frac{4\varrho bh}{M};$$

but $4bh$ is the volume of a prism of the fluid whose base is b, and whose height is $4h$; and $4\varrho bh$ is the mass of fluid which has the surface b for its base, and 4 times the height due to the velocity v for its altitude; therefore, by assuming M equal to unity, *the resistance* R *will be equal to the mass of a prism of the fluid, whose base is the area of the fluid vein, and whose height is four times the fall productive of the effluent velocity.*

This result corresponds with the formula given by Daniel Bernoulli, in the 2d volume of the *Comment. Petropol.* in the year 1727; although he afterwards calls this determination in question in his subsequent theory of Hydrodynamics, as he found that it gave a resistance four times greater than experiment.

But however this may be, it nevertheless appears at least to be confirmed by the experiments of d'Ulloa; for he found, that the resistance of a board one foot square, and immersed in a stream, moving at the rate of two feet *per* second, was $15\frac{1}{4}$ pounds avoirdupois,—a result very nearly corresponding with that deduced from the preceding formula, which gives for *rain-water* about $15\frac{1}{10}$ lb. weight avoirdupois.

Notwithstanding, it is necessary to avow, that this resistance greatly exceeds all the values given by other authors: it is in fact more than double the resistance assigned by the members of the Academy of Sciences at Paris, whose determination is generally considered to be the most accurate of any yet given. This great diversity in the values which different authors have deduced from their experiments for the absolute resistance of water, is very remarkable; and it should induce philosophers to exert their utmost efforts in endeavouring to detect any fallacy that may have crept into the principles or reasonings by which the result of the theory has been deduced; and in multiplying experiments, with a view to obviate the great disparity that still exists in the absolute value of the resistance, as determined by different authors. I am well aware that this cannot be accomplished, without incurring a considerable expence; and it is this consideration *alone*, that deters me from making the attempt, and not the difficulty of the undertaking; for, however arduous it may appear, I imagine it might be overcome by a steady perseverance and attention.

It may not be irrelevant to remark here, that when water escapes from a vessel through a small orifice, perforated in one of its sides, the *effective* discharge is only about 0,62 of the *theoretical*, owing to the *contraction* of the fluid vein,—a circumstance which has not been taken into the account in the preceding investigation: this reduction being made in the value of R, when the mass M is assumed equal to unity, *the resistance will be found* NEARLY *equal to the mass of a prism of water, whose base is equal to* b, *the area of the fluid vein, and whose height is equal to twice the fall producing the effluent velocity.*

It should also be remarked, that the result of the preceding investigation is not rigorously exact, because a portion of the fluid is thrown back on the sides of the plane surface, in consequence of which, it is neither so much urged, nor so continually impelled as before; but notwithstanding this, it leads to an approximation, at which, however, we are obliged to stop, on account of the insuperable difficulties of the subject. This remark is due to Francœur. Nevertheless, this approximation is the limit to which the real phenomena of the impulse and resistance of fluids continually approach. When, therefore, the law by which the phenomena deviate from the theory, shall be once dedetermined, by a well chosen series of experiments, this approximate theory will become nearly as valuable as a true one; for the rules and practice of computation are established *even* beyond controversy; and since the process of investigation is allowed to be legitimate, we may employ it as a means for discovering the imperfections of the theory; for, instead of assigning the motions by means of the supposed forces and the known mechanism, we may, conversely, determine the forces by means of this mechanism and the observed motions.

It appears, both from theory and experiment, that the impulses and resistances are very nearly in the proportion of the surfaces which bodies present to the *direct* action of fluids. In fact, the Chevalier Borda has found, that, with the same velocity, the resistances increase somewhat more rapidly than the surfaces; and he has remarked, that the deviation from the theory increases with the surface. This is a most interesting circumstance, particularly with regard to the extensive surfaces of the sails and hulls of ships; and when taken in connection with the effective *oblique* impulse, which in acute angles is found to be much greater than in the ratio of the square of the sines of the angles of incidence, it will be found that it has the "chief influence on all the particular modifications of the resistance of fluids." And as it is on these two circumstances that the whole theory of the construction and working of vessels, and the action of water on our most important machines, depend, they certainly merit the most particular and attentive consideration of our naval constructors and civil engineers.

Having thus completed the investigation of this interesting problem, I shall now proceed to answer some objections that have been urged against it by the writer of the article "Resistance" *of Fluids* alluded to above.

1. The writer begins with stating, that there is nothing in experimental philosophy more certain, than that the resistances are very nearly in the duplicate ratio of the velocities, and that he cannot conceive by what experiments the ingenious author (d'Ulloa) has supported the conclusion which is contained in the equation (2). The answer to this objection has already been anticipated, as it has been proved, that if we assume $\sqrt{h} = \frac{v}{\sqrt{2g}}$, this supposition will give, $R = \frac{2\varrho b'}{M} \times v^2$; and the

the author's own experiments seem at least to support his conclusion.

2. It has been objected, that there is an essential defect in the investigation of the problem in question; because, says the objector, the equation (2) exhibits no resistance in the case of a fluid without weight, and because a theory of the *resistance of fluids* should exhibit the retardation arising from *inertia* alone, and should distinguish it from that arising from any other cause.

In combating this objection, I remark, that this essential defect complained of above, is *a mere nonentity;* for the fact is, that the equation in question does *really* exhibit a resistance, even in the case of a fluid *destitute of weight;* because the value of the mass M is independent of the weight; and the same is true of the difference of the two *dead pressures*, which difference constitutes the equation (2), notwithstanding it involves the quantity $\frac{v}{\sqrt{2g}}$, which is nothing more than the expression of a ratio, that is, of an abstract quantity. Hence it follows, that this equation does *bonâ fide* exhibit the retardation which arises from *inertia* alone.

3. Another objection is, that while the equation (2) assigns an ultimate sensible pressure, proportional, *cæteris paribus*, to the *simple* velocity, it assumes as a principle, that the pressure p is as $(u \pm v)^2$. It will be sufficient to reply to this objection, that the *ultimate sensible resistance* has already been proved to be as the *square of the velocity*—a conclusion which is in unison with the principle assumed, namely, that the pressure p is proportional to $(u \pm v)^2$.

4. As to the objection, that the equation (2) gives a *false* measure of the statical pressures, which are affirmed to be made up of the pressure of the incumbent water, which is measured by h, and the pressure of the atmosphere a constant quantity, it is of *no force*; because it was never meant that it should give the complete measure of the statical pressure, but only the pressure of the incumbent water, which is measured by the height h,—not *even* when the value of v is such that a perfect vacuum is left behind the surface o,—a case which I believe

never actually occurs, but which will be more particularly considered when we come to reply to the fifth objection.

5. The only other objection that deserves notice, is, that whatever reason can be given for setting out with the principle that the pressure on the little surface *o*, moving with the velocity v, is equal to $\frac{1}{2} \varrho b (u \pm v)^2$, makes it indispensably necessary to take for the velocity u, not that with which water would issue from a hole, whose depth under the surface is h, but the velocity with which it will issue from a hole whose depth is $h + 33$ feet; because this is the velocity with which it would rush into the void left by the body, &c.

This objection is the most plausible of all, and seems, at the first glance, to carry considerable weight with it; but it is not very difficult to shew that it is more specious than solid. When, indeed, the velocity v is very great, and such that a perfect vacuum is formed behind the small surface *o*, in this extreme case it must be admitted that the objection would be valid; but when the velocity v is not very great, the surrounding fluid will press in behind the surface *o*, and, in a great measure at least, balance the anterior pressure which it sustains. In like manner, the pressure of the incumbent atmosphere, both before and behind the surface *o*, will nearly balance each other's effects, and be transmitted *even* to the surface *o*, by means of the intervention of the different horizontal strata of the water; so that when the velocity v is not very great, the velocity u, with which the water would issue from the orifice, at the depth h, below the upper surface of the water, will be that which is due to the height h nearly, and not to that of $h + 33$, as stated by the objector.

Thus have I been at some pains to inform the reader of my reasons for adopting this theory of the resistance of fluids, notwithstanding that it has been asserted by persons, to whose judgment I pay the utmost deference, to be "contrary to received opinions, and to the most distinct experiments."

CUSTOM-HOUSE, PENZANCE,
May 1820.

Art. XII.—*Description and Use of a very Sensible Electrometer, for indicating the Kind of Electricity which is applied to it.* By Professor Bohnenberger *.

About nine years ago, M. Behrens published the Description of an Electrometer, which indicates the kind of electricity that is presented to it †; but it appears to have been forgotten, with the dry electrical columns, which formed an essential part of the apparatus. The *Electrical Perpetual Motion* of Zamboni reminded me of this electrometer, and I engaged M. Butzengeiger to execute one of them, which I shall proceed to describe.

A cylindrical vessel of glass, about $2\frac{1}{2}$ inches in diameter, and $3\frac{1}{2}$ high, has fitted to it a brass-cap, from which two small dry electrical columns descend into the vessel, and are attached to the cap by screws, so that the one has its positive and the other its negative pole, making a slight projection above the cap. Each column is composed of 400 discs of gold and silver paper, glued together, and three lines in diameter, so as to fill two tubes of varnished glass. Each of these tubes is terminated below by a ring of brass, projecting a little, and rounded, which is in electrical communication with the discs. When the brass-cap is in its place, the columns descend vertically, and the lower ring is $\frac{1}{4}$th of an inch distant from the bottom of the glass. The axes of the columns are 1 inch and 7 lines distant, but may be brought nearer one another. From the centre of the cap rises a tube of glass, varnished within and without, and within the tube is a brass-wire kept in the axis by a cork, but touching the tube no where else. At the lower end of the brass-wire is suspended a piece of gold leaf $2\frac{1}{2}$ inches long and 3 lines wide, exactly in the middle of the interval between the two columns, and parallel to their axis, if they are accurately vertical. At the upper end of the brass-wire is a small brass-ball, upon which may be screwed one of the discs of a condenser, as in the electrometer of Volta. By this arrangement, the electrical

* Translated from the *Bibliotheque Universelle*, November 1820, p. 163.

† *Annalen der Physik*, tom. xxiii. cap. 1.

columns which Behrens had placed without the glass, which defends the gold-leaf from the agitations of the air, are placed within the glass, so that their position is not only better preserved, but they are defended so completely from moisture, dust, &c. that they retain the same electrical intensity.

This electrometer is used in the following manner: The cap of metal is put in communication with the ground by means of a metallic wire, and by touching the brass-ball, any accidental electricity is discharged, which may belong to this part of the apparatus. If one has a dry skin, the touch of the finger is not sufficient. As the gold-leaf is suspended between the columns, at the level of the rings of metal which terminate them, the one positively, and the other negatively, the gold-leaf is attracted equally on both sides, and remains quietly in the middle in its ordinary state; but if, by means of the metallic wire, we communicate to it the weakest degree of electricity, the lower extremity of the gold-leaf is attracted by the ring, which possesses an electricity opposite to that which is communicated. Having come in contact with this ring, it is successively repelled and attracted by the opposite ring. This oscillatory motion continues till the gold-leaf attaches itself to one of the columns, from which it may be easily detached by touching the brass-wire, so as to dissipate its electricity, and by shaking the instrument. In order to determine the nature of the electricity, the upper poles of the two columns which project above the brass-cap have the signs + and — upon them, and the electricity required is that which is indicated by the sign of the column towards which the gold-leaf first moves, or which it first touches, when the electricity is stronger.

By this electrometer, strong and weak degrees of electricity may be equally well examined. In the first case, the electrified body is made to approach slowly and at a distance the ball of the electrometer, till the gold-leaf is put in motion towards one of the columns. If, for example, we bring an excited stick of sealing-wax to the distance of about three feet from the ball, we shall observe a motion of the gold-leaf towards the column marked —. If we bring it to a less distance, it will strike the column, from which it may be easily detached, by bringing the wax still nearer. In the second case, the electrified body must be moved much nearer the ball, and brought into contact with it, if necessary, till the gold-leaf is put in action. This degree of electricity is so weak, that it would be absolutely insensible in the ordinary electrometer of Bennet.

When the electricity is still feebler, we may advantageously employ a condenser adapted to the instrument. The circular plate, on the margin of which is screwed the ball of the electrometer replaces the cover of the condenser, and a plate or disc furnished with a glass handle, and which is placed above the first, represents the base. These plates are covered with a thin coating of amber-varnish on the faces which are brought into contact. If we wish to try a very weak electricity, we first touch, in order to deprive it of its electricity, the inferior plate, or the wire which carries the ball; we then place above it the other plate, and afterwards touch the lower plate or its wire, with the body whose electricity we wish to examine, touching, at the same time, the upper plate, in order to deprive it of its electricity. The upper disc is then removed by its glass handle, and we observe towards which of the two small columns the gold-leaf is carried, and the sign marked upon this column will indicate the kind of electricity. If, for example, we put in contact with the lower surface of the lower plate of the condenser a a small disc of zinc, about $\frac{3}{4}$ths of an inch in diameter, and press it against this plate, without touching the plate with the finger, and if we touch at the same time the upper disc of the condenser, to deprive it of its electricity, and if we afterwards remove the disc of zinc on one side, and on the other side the upper plate, we shall observe the gold-leaf approach the column marked *minus*. A similar effect will be observed, if we put in contact with the disc of the apparatus the metallic side of a piece of silvered paper.

It will often be more convenient to put the body we wish to examine in contact with the upper and moveable plate, and touching the inferior plate, to deprive it of its electricity, proceeding in other respects as we have already described. The electricity, however, which the instrument now indicates, will be opposite to that which is communicated to the upper plate, because, by this method, the plate united to the instrument forms the base of the condenser.

If the body which we examine cannot be conveniently put in immediate contact with the lower plate of the condenser, a communication with it may be formed, by means of a metallic wire, with an insulating handle, the rest of the operation being the same as before.

Art. XIII.—*Observations on the Countries of Congo and Loango as in* 1790. By Mr Maxwell, Author of the Letters to Mungo Park, &c. &c. *

Princesses of Cabenda.—In the kingdom of Cabenda, or Anjoya, princesses of the royal blood rule with despotic sway, and are to all appearance, devoid of that gentleness, which in other countries forms one of the brightest ornaments in the female character. They are possessed of the extraordinary privilege of compelling any subject, under the rank of prince in his own right, to marry them, and renounce wives and children for their sake. The richest merchants are chiefly exposed to their rapacity. When the unhappy individual thus promoted to honour has been stripped of his wealth, and another victim to arbitrary power selected in his place, he is permitted to return to private life; with this consolation however, that he is entitled by courtesy to the appellation of Prince. During his continuance in this splendid slavery, he must not, at the peril of his life, be seen in company with any other woman. The risk attaches equally to all women who may chance to come in his way. To provide therefore as much as possible against such casualties, he is always attended by a guard of honour, part of which, when he is visiting, or on a journey, precedes him at a considerable distance, beating the Chingonga, a double bell (a bell at each extremity of a semicircular arch), the sound of which is instantly recognised by females, who conceal themselves until the object of their terror is past. To complete this monstrous picture of human weakness, these princesses, in order to insure the success of the predatory excursions in which they are not unfrequently engaged, stand upon an elevated situation, and cause the army to pass in review between their legs. I know several merchants ennobled by an

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* See this Journal, vol. iii. p. 102.

alliance with these Amazons, of whose tyranny they complain bitterly. Notwithstanding the manifest want of circumspection evinced in their own conduct, they exact the most scrupulous decorum from their husbands towards women.

I am not aware that a similar custom prevails in the adjoining province of Chimfooka, or in any other part of the coast between Mayumba and the Congo.

Priests.—The Patriarch or High Priest, Boonzie, resides at Maccatala. His spiritual jurisdiction is very extensive, and his person is held so sacred, that no one, however high his rank, presumes to approach, or even address him, when admitted to his presence, until a sign is given, whereupon the obeisance paid him approaches to adoration.

Every audience is accompanied by a present, valuable in proportion to the wealth of the person suing for patronage or redress; but as Boonzie is believed incapable of taking a bribe, he is solicited to inspect the present; and those articles he approves of, being tied loosely to the parcel, drop off whilst the attendants are retiring with it.

None of the princes, to a considerable distance from Maccatala, consider themselves safe under the patriarch's displeasure. There is therefore a constant resort to his residence; and his office thus becomes a source of much emolument.

The district of Maccatala is held sacred by all the neighbouring nations, and happy do they esteem themselves who can get the bodies of their departed friends deposited in that hallowed ground; an opportunity, of which those bordering on the river, never fail to avail themselves. Canoes may be seen almost every day at Embomma, going down the river to Maccatala with dead bodies. They are always distinguished from other canoes, by some particular mark of funeral solemnity. *Voombi quenda Maccatala!* would the natives on board answer, when asked where these canoes were going.

The present patriarch is about sixty years of age, a dignified and venerable looking man, no way distinguished by his dress from the other chiefs. He was the first person with whom, in sailing up the river, I had an interview, and but for the sanctity of whose character, (on which he laid great stress,) I had found it no easy matter to bring the natives to a parley. Upon coming to anchor near Oyster Haven, we discovered four people upon Hope Island, and being desirous of a conference, I sent the mate and four men in a small boat, provided with trinkets, to distribute amongst them. The natives, as we could perceive from the ship with our glasses, awaited unmoved, the approach of the boat, until the sail was furled and exchanged for the oars; then, with great precipitation, they took a canoe upon their shoulders, and carrying it across the island, launched it, and paddled in the utmost haste to Maccatala. The following day at noon, a canoe being observed hovering along the north shore, I proceeded towards it in the small boat, but as we approached, it slowly retreated to the entrance of a small creek. Our pacific appearance at length induced it to wait for us. A man stood on the prow, speaking vociferously, and with much gesticulation. This was Boonzie himself.—He made a long harangue, in which he took care to make himself known; and concluded by saying, that if I offered him any injury, Enzambi Empoongu would punish me. A present of beads, cloth, and brandy, dispelled his fears, and in return, he gave me a fine goat, and a bunch of plantains; and requested that his son, Chimpola, might accompany me on board.

Maccatala abounds in beautiful and magnificent sylvan scenery, and is altogether "a happy rural scene of various view." The villages are built in the open cultivated spaces, with which the woods are interspersed; and are surrounded by plantations of cassava, Indian corn, plantains, peas, tobacco, &c. In one of these pleasing solitudes, resides Chinganga Boonzie, an inferior member of the priesthood.

Ordeal Trial.—When any one is falsely accused of an atrocious crime, he can only prove his innocence by passing, unharmed, the ordeal trial of Cassah. This consists in swallowing a certain quantity of the cassah, which is administered by a person called Ganga Emcassah. Upon a day appointed, the accused makes his appearance, and on demanding to drink the cassah, the Ganga administers it in presence of a great concourse of people, who, arranging themselves in a circle around him, await with eagerness the effect of the poison. If it causes great sickness and stupefaction, he is pronounced guilty; but if it does not, or if it produces vomiting, he is immediately declared innocent, presented with a mark of distinction upon the spot, and is ever after thought worthy of unreserved confidence. The attestation of his innocence is merely a piece of calabash shell, about the size of a dollar, painted white, and fastened, by means of a string embracing the circumference of the head, to the right temple. My friend, Captain J. V. Aubinais of Nantz, witnessed one of these trials: it was that of a woman accused of infidelity to her husband. The moment she began to sicken and stagger, the spectators burst into the circle and dispatched her with their knives and daggers, first cutting off her breasts. Such a custom is too savage to enlarge upon; but it appears evident to me, that the fate of the unfortunate individual is determined beforehand, according to his wealth or power, and that when he does escape with impunity, some less deleterious drug must have been substituted for the cassah. This poison is prepared from the bark of a tree; its colour is a bright red; and the fracture of the bark presents a resinous appearance.

Palm Tree.—The palm is the most valuable tree that grows in Africa. Besides wine, it yields a sweet nutritive oil; with its leaves the natives thatch their houses; and with the small wiry threads that hang from its branches, they string their musical instruments; not to mention many other useful purposes it serves. It sometimes attains the height of 120 feet; but the stem, considering its great length, is slender. The branches fall off annually, and leave knobs like those of a cabbage stalk.

The natives in this part of Africa are extravagantly fond of palm wine, which is very pleasant to the taste when first drawn from the tree; but until it has undergone fermentation they seldom drink it: then, although not so agreeable to an European palate, they relish it more highly; perhaps from the inebriating quality it has acquired.

The wine is obtained by making an incision in the tender head of the tree, and collecting it in a calabash, into which it is conveyed by means of a small splinter of wood, communicating with the incision. The mouth of the calabash is lightly covered with dry grass, to keep off the swarms of flies and wasps. It is then left until such time as, from experience, it is known to be nearly full; when a man again ascends the tree with empty vessels at his belt, to replace the full ones, which he brings down in the same manner. This, notwithstanding the height of the tree, is easily accomplished. The climber provides himself with a tough woodbine hoop, the circumference of which embraces the tree and his body, but with so much space intervening, as permits him to lean back at arms-length from the tree, thus enabling him to fix his feet firmly against the knobs. In this way, by jerking the hoop upwards, he ascends very quickly.

The wine is always extracted from the male tree; the female, which bears the nuts, being too valuable to use in that way. The nut is nearly of the size and figure of the walnut. Each tree produces three or four bunches, which are sometimes so large that a single cluster has been known to weigh above 100 pounds.

(To be continued.)

Art. XIV.—*On the Method of finding the Dip or Depression of the Horizon.* By Adam Anderson, Esq. A. M. F. R. S. E.

The altitude of a heavenly object, as it is obtained by observation, being an arch of a vertical circle intercepted between the object and the apparent horizon, it is evident that this arch must be greater as the eye of the observer is raised above the plane of the horizon. Let A, Plate VI. Fig. 4. be any place on the surface of the earth, b AB the sensible horizon of that place, A′ a point directly vertical to A, and b'A′B′ the corresponding horizontal plane; then C being the centre of the earth, if O be an object at a great distance, the angle B′A′O, will not differ sensibly from the angle BAO, the apparent altitude at A; but at A′ the apparent altitude will not be the angle B′A′O. but the angle OA′E, which differs from the former by the angle B′A′E. This difference, which varies with the altitude of the observer, is called the *Dip* of the horizon, and is equal to the angle at the centre ACE. We shall compute the magnitude of it for a particular altitude in feet, and then give a general expression, by which it may be determined with sufficient accuracy in all other cases.

Let r denote the radius of the earth, corresponding to the mean parallel of 45°, in which case it is 20972190 feet; then, if h be the height of the observer, in feet, above the surface of the ocean, and t the tangent at the point A′.

$$t = \sqrt{DA' \times AA'} = \sqrt{2\,r\,h + h^2}.$$

But if the arch AE, which, from what we have shewn, must measure the dip, be represented by D, then, from the well known expression for an arch, in terms of its tangent,

$$D = t - \tfrac{1}{3}\,t^3 + \tfrac{1}{5}\,t^5 -, \text{ \&c.}$$

If t be expressed in terms of the radius, considered as unity, then h must be divided by 20972190, by which means it will become a very small fraction, and it will be quite unnecessary to retain more than two terms of the above series. We shall thus have $t = \left(2h + h^2\right)^{\frac{1}{2}}$, and

$$D = \left(2\,h + h^2\right)^{\frac{1}{3}} + \frac{1}{3}\left(2\,h + h^2\right)^{\frac{3}{2}};$$

$$\text{or } D = \left(2\,h + h^2\right)^{\frac{1}{2}} \left\{1 + \frac{2\,h + h^2}{3}\right\}.$$

This expression will give the dip in minutes, if it be multiplied by 3437.75, the number of minutes equal to the radius, when the circumference is 360°; but before it can be used for practical purposes, it must be corrected for atmospherical refraction. At present it is sufficient to state, that, according to La Place and De Lambre, the effect of refraction, in the ordinary condition of the atmosphere, is to increase angles of elevation observed near the surface of the earth, $\frac{8}{100}$ of the intercepted terrestrial arch between the object and the place of the observer. Hence the angle AA′E must be multiplied by $\frac{100}{108}$ to reduce it to its proper magnitude divested of refraction. We thus obtain

$$D = 3437.75 \times \frac{100}{108}\left(2\,h + h^2\right)^{\frac{1}{2}} \left\{1 + \frac{2h + h^2}{3}\right\}$$

For elevations not exceeding 400 feet, it will be sufficiently correct to give this expression the form

$$D = 3183\,\sqrt{2\,h + h^2}; \text{ or even } D = 3183\,\sqrt{2\,h}.$$

$$\text{Thus if } h = 25 \text{ feet, then } h = \frac{25}{20972190} = \cdot 00000119205.$$

$$\text{And } D = 3183\,\sqrt{\cdot 0000023841} = 3183 \times \cdot 00154 = 4' \cdot 9.$$

It appears by the approximated expression, $D = 3183 \sqrt{2h}$, that the dip for different elevations above the level of the sea, is nearly proportional to the square root of the height; and since we have found it 4′.9 for 25 feet, we obtain for any other height in feet H,

$$D = \frac{4.9}{5} \sqrt{H} = \sqrt{H} \text{ nearly.}$$

Hence the dip in minutes is very nearly equal to the square root of the altitude in feet. This method of finding the dip, the simplest, we believe, that has yet been given, will seldom differ in result above four or five seconds from the most rigid calculation, and, considering the changeable nature of the height of the observer at sea, may be regarded as sufficiently correct for all practical purposes. We deduce from ti the following practical rule for the calculation of the dip: Take half the logarithm of the height of the eye of the observer in feet, and it will be the logarithm of the dip in minutes.

Example.—What is the dip of the horizon for an observation taken at the height of 45 feet above the ocean?

Log. 45 = 1.65321
$\frac{1}{2}$ of which is ·82660 = Log. of 6·7.
Hence the Dip is 6′.7, or 6′.42″.

The relation deduced in the preceding investigation, is one of the few coincidences among the objects of science, which are readily impressed on the mind, by their singularity and simplicity. Those who are acquainted with the allowance for the depression of the earth's surface below the tangent at a particular point, will at once recognize a similarity in point of simplicity between the above expression for dip, and the usual correction for curvature, in conducting the operations of levelling. In that case, the tangent line, or the direction indicated by an accurate level, is elevated above the true level, by a quantity expressed in feet, which is obtained by taking two-thirds of the square of the distance in miles. The relation between the height of the eye and the dip is still more curious, and not less simple; but the singularity of the coincidence, in the two cases, is the more remarkable, as they both depend on the particular magnitude of the earth, and the accidental length of the English foot.

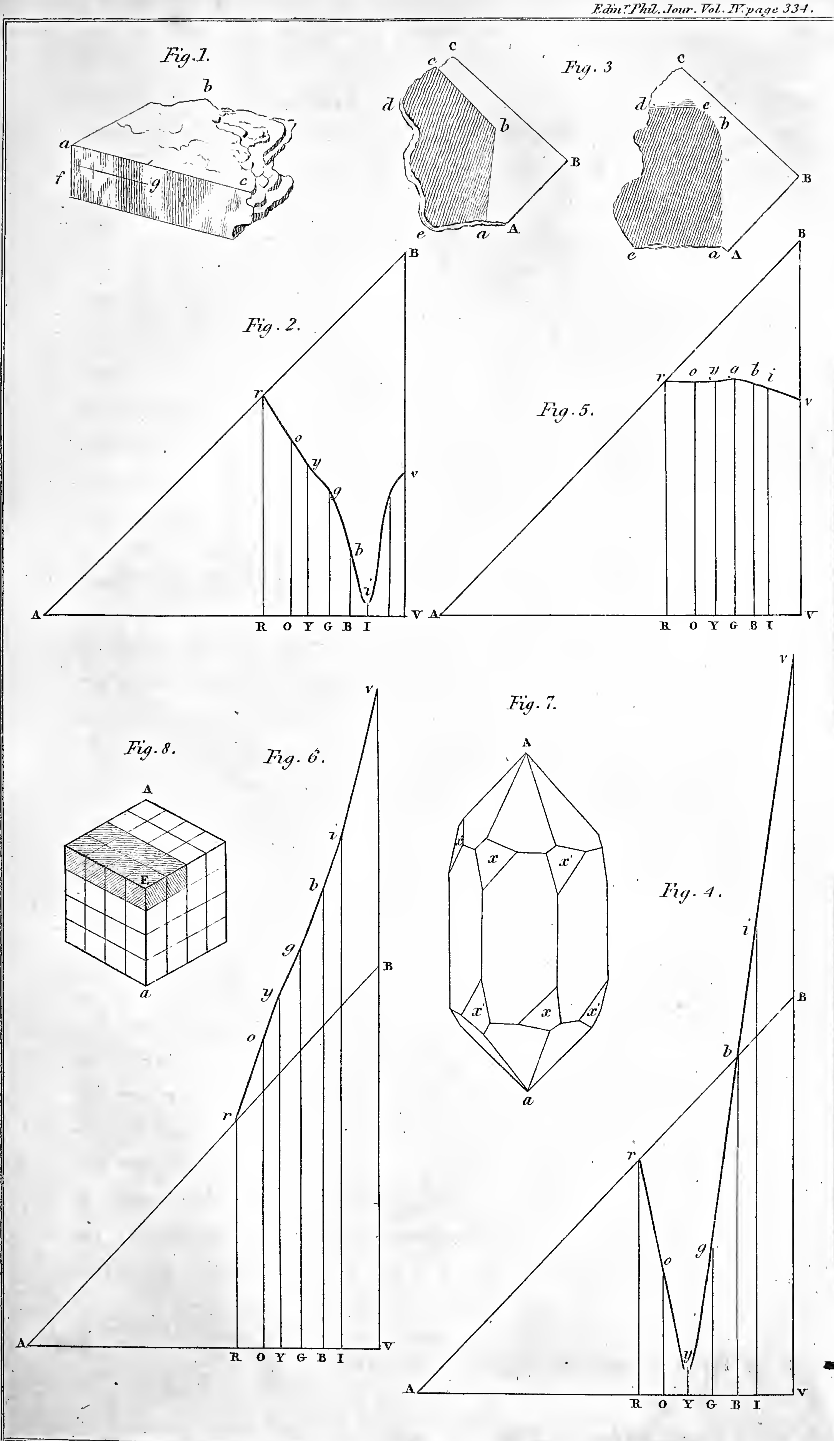
Art. XV.—*On certain remarkable Instances of deviation from* Newton's *Scale in the Tints developed by Crystals with one Axis of Double Refraction, on exposure to Polarized Light.* By J. F. W. Herschel, A. M. F. R. S. Lond. & Edin. and of the Camb. Phil. Soc. *

THE discovery of crystals which possess Two axes of double refraction, which we owe to Dr Brewster, is, perhaps, the greatest step which has been made in Physical Optics since the discovery of double refraction itself by Bartholin, and its reference to an axis by Huygens. It has opened new views on the structure of crystals, and will, in all probability, be the means of leading us to a more intimate knowledge of the nature and laws of those forces, by which the ultimate particles of matter act on light and on each other. When we reflect on the situation of these axes in different crystallized media, we cannot fail to be struck by the variety of the angles they include, and of the positions they hold, with respect to the prominent lines or axes of symmetry of the primitive molecules, and the question immediately suggests itself, What are the circumstances which determine their position in the interior of a crystal?

It seems to have been all along taken for granted, that whatever these circumstances may be, the nature of the ray must at least be a matter of indifference; in other words, that a red and a violet ray similarly polarized, and incident in the same direction on the same point of a doubly refracting surface, will either both undergo, or both not undergo, a separation into two pencils, without any distinction arising from the place of the ray in the prismatic spectrum. Were this the case, the two axes would be fixed lines within the primitive form, absolutely determined by the nature of the body, as much so as the lines which bound the primitive form itself, and any attempt to substitute for them hypothetical axes, coinciding with remarkable lines in the latter figure, however ingeniously devised, must be regarded as mere speculation. The fact, however, is other-

* From the *Memoirs of the Cambridge Philosophical Society*, vol. i., which will soon be published. This paper was read on the 1st May 1820.

PLATE VII.



W. Archibald Sculpt. Edinr.

Published by A. Constable & Co. Edinr. 1821.

wise. In a paper recently presented to the Royal Society, I have shewn that the axes of double refraction in one and the same crystal differ in their position according to the colour of the intromitted ray, a violet ray being separated into two pencils, when incident in the same direction in which a red one would be refracted singly. This remarkable fact, which is almost universal in crystals with two axes, places the question in a very different light. It appears that the nature of the ray, as well as that of the medium, has its share in determining the position of the axes, and that the intensity of the action of the medium on the ray is one of the elements involved in this problem. Now, it is hardly possible to conceive the neutral axis of a crystal otherwise than as a position of equilibrium, or direction in which the axis of translation of a luminous molecule (if such exist) must be placed, that certain forces may act in opposition, and balance one another; but since forces which balance will likewise counteract each other when increased or diminished all in the same ratio, it follows that the partial or elementary forces so held in equilibrium do not observe the law of proportionality, when the colour of the incident ray varies. If we suppose, then, with Dr Brewster, that these partial forces emanate from certain fixed axes coincident with remarkable lines in the primitive form, it will follow that each separate axis has a peculiar specific law, which regulates the intensity of its action on the differently coloured rays, and that each axis, supposing the others not to interfere with it, would exhibit separately a set of circular rings, of which the tints would manifest a more or less marked deviation from the Newtonian Scale of Colours, as displayed by their uncrystallized laminæ.

This view of the subject will be remarkably supported by the facts about to be described, by which it will appear, that among crystals with one axis only, there exists the greatest, I might almost say the most capricious diversity in this respect, and that probably no two crystals, either with one or two axes, have the same scale of action, or polarize the differently coloured rays with an energy varying according to the same law precisely.

To this it may be objected, that from the result of a most elaborate examination of the colours exhibited by sulphate of lime, rock-crystal, and mica, M. Biot has concluded that they follow in their action on coloured light, precisely the order and proportions stated in the Table of Newton, for the colours of thin plates of air. This coincidence is certainly extremely remarkable, supposing it rigorously exact *; and antecedent to further experience, would appear to authorise the conclusion, that the proportional lengths of the periods performed by differently coloured rays within crystallized bodies, depend essentially on the nature of the rays themselves, and not at all on the interior constitution of the crystal. Indeed, in a case very analogous, M. Biot himself has attributed great and decisive weight to a presumption resting on the very same grounds. I allude to his Memoir on the Rotatory Phenomena exhibited by rock-crystal, and certain liquids, where having observed that, in the former substance, the rotatory velocities impressed on the planes of polarization of differently coloured rays, are inversely as the squares of the lengths of their fits; he argues, that this relation being independent of any datum involving the peculiar constitution of rock-crystal, ought to be the general law for all other substances which possess the rotatory property. "Où pourrait considérer d'abord que la rotation dans le cristal de roche s'étant trouvée réciproque aux carrés des longueurs des accés des divers rayons simples, cette loi se présente comme une propriété des rayons mêmes, et non comme une résultat dependant de la nature des corps qui agissent sur eux. Ou doit donc s'attendre, d'après cette remarque, que la même loi subsistera dans toutes les substances, comme on y voit se maintenir les rapports des accès mêmes dont la seul longueur absolue varie."

However convincing this line of argument may appear, and however exactly supported by experiment in the case of the rotatory phenomena, its conclusions are not verified in that of the polarized rings, to which it nevertheless applies with as much or greater force, as in the other instance; and this may serve to shew how very cautious we ought to be in our attempts to generalise antecedently to experience in this branch of optical science. In the paper above alluded to, I have demonstrated that

* M. Biot's conclusion was deduced principally from *sulphate of lime;* but even in this substance the tints are *not* those of Newton's Scale. Round the resultant axes the tints are of a very peculiar nature, as I shall have occasion to shew in a separate Memoir on this subject.—D. B.

this law of proportionality admits of exceptions; and to the instances there adduced, I have now to add other still more remarkable ones, which, if I mistake not, afford abundant proof *that it has no foundation whatever in the nature of light.* Indeed, it may be observed, that the last sentence in the passage just quoted, is sufficient to destroy, in a great measure, the force of the argument in the former part of it: for, since Newton has demonstrated, that for rays of a given colour, the lengths of the fits in different media are proportional to the sines of refraction corresponding to a given angle of incidence out of a vacuum, and since the more recent discovery of the different dispersive powers of substances has proved that media differ very considerably in the proportion of these sines for the different rays of the spectrum, it follows that the proportional lengths of the fits must differ in every different medium. Hence will arise a difference in the scale of colours which thin laminæ of different media should exhibit; and though we may certainly fix on one (that exhibited by a vacuum for instance) as a standard, and call it the Newtonian Scale, yet this, though convenient, is nevertheless in some degree arbitrary, as we know not the nature of the media, with which what we call a vacuum may be filled, nor their action on light. Nor is this cause of deviation so small as to be safely neglected in all cases. In oil of cassia, the difference in the refractions of red and violet rays amounts to no less than $\frac{14}{100}$ of the whole refraction, and the colours exhibited by thin or thick plates of this liquid should therefore deviate very sensibly from those in air or *in vacuo.* Various solids, too, as chromate of lead, realgar, &c. could they be obtained by any means, in sufficiently thin leaves, ought to exhibit a scale of colour differing altogether from that of Newton.

The very remarkable succession of colours exhibited by that variety of the Fish-eye stone (Apophyllite), which possesses a single axis of double refraction, has been noticed by Dr Brewster, and since shewn in my paper already alluded to, to indicate an action on polarized light, very nearly the same for all the colours, being equal upon the red and indigo-blue rays, a little greater for the yellow and green, and a little less for the violet, being the only instance yet adduced in the whole circle of optical phenomena of a maximum taking place between the extreme limits of the spectrum. I was led by this to conceive the possible existence of bodies, in which the law of proportional action should be so far subverted, as to render the periods performed by a red ray, within their substances, actually shorter than those passed through by a violet one; but certainly did not expect to find my conjecture almost immediately verified in the striking manner I am now to detail, and on the very substance which first gave rise to it.

By the kindness of my friend Mr Lowry, (to whose liberality in rendering his invaluable collection accessible to scientific examination, I have every reason to bear honourable testimony,) I was provided with a very large, and indeed splendid crystal of Fish-eye stone, which, though not very transparent, owing to air included between its laminæ, was yet sufficiently so to exhibit the rings of one axis with perfect distinctness, especially after a few days' immersion in oil of turpentine. The character of these rings was, however, altogether different from that of the rings exhibited in the ordinary variety; their tints, instead of being alternately white and black, with a little intermediate shading of lilac and greenish-yellow, as described by Dr Brewster, being those of the following Table, in which the colour of the extraordinary pencil only is given.

TABLE I.

1st *Order*.	Black, ruddy or yellowish-white, white, faint blue, violet.
2d *Order*.	Indifferent pink, orange-yellow, dilute imperfect green, blue, purple.
3d *Order*.	Good pink, orange-yellow, tolerable green, blue, purple.
4th *Order*.	Fine pink, yellow, green, light blue, indifferent purple.
5th *Order*.	Rich pink, yellow, bluish-green, indifferent purple.
6th *Order*.	Pink, pale yellow, pale green.
7th *Order*.	Pink, whitish, pale green.
8th *Order*.	Pale pink, whitish, pale green.
9th *Order*.	Ditto, ditto.
10th *Order*.	Very pale pink, very pale green.
11th *Order*.	Extremely pale pink, extremely pale green.
12th *Order*.	Scarcely perceptible pink and green.

In this series, the less refrangible rays evidently perform their periods with greater rapidity than those of the opposite end of the spectrum, but the number of alternations is still pretty considerable, and indicates a nearer approach to equality between the extreme red and violet than in the Newtonian Scale. Struck by this circumstance, a passage in a letter of M. Biot, dated October 21. 1819, now occurred to my recollection, in which, speaking of the conclusion I had arrived at by observations on homogeneous light in the ordinary variety of this mineral, he says, "Si vous êtes bien assuré de cette anomalie, je désirerai beaucoup que vous voulussiez bien essayer si elle se soutient à toutes les épaisseures, ou si elle éprouve quelque variation avec la longueur du trajet que fait le rayon à travers la substance cristallisée. Je serais extrêmement curieux de savoir lequel de ces deux cas a lieu."

To this surmise of a variation in the proportional lengths of the periods depending on the thickness of the plate, or the length of the path traversed within the crystal, all my previous observations had certainly enabled me to answer decidedly in the negative. But so singular a deviation from what I had before observed, led me to suppose that there might be something in this observation deserving a minuter examination, and I resolved to sacrifice this specimen to the inquiry. The result, as will be seen, by a most accidental coincidence, actually verified the suggestion of that acute philosopher, though in a way which he certainly never could have contemplated.

The crystal is represented in Plate VII. Fig. 1. It was about $\frac{3}{4}$ inch in its greatest breadth, and 0.27 inches in thickness, being a portion of a right prism, the plane angle (bac) of whose base was about 96°. The sides were striated longitudinally, and appeared to have been encased with a thin and highly polished exterior coat, of which a small portion was still adhering *. The structure was perfectly lamellar, the laminæ being parallel to the base of the prism. On examining it more narrowly, a remarkable flaw was perceived commencing at f, and running along fg, parallel to the laminæ. On this I set the edge of a knife, and succeeded without difficulty, by a smart blow, in cleanly separating the two portions. The little irregularities in their surface being ground away, and a good polish communicated to them, their thicknesses were taken by the

* The specimen, as I learn from Mr Lowry, was brought from Utöe in Sweden, and was attached to a mass of oxidulous iron.

sphærometer, and found respectively 165900 and 94499 millionths of an inch. On examining them separately in polarized light, I was now much astonished to find the rings exhibited by the two portions, though both circular, yet differing altogether in their characters. Those in the thicker portion were in every respect precisely analogous in the scale of their tints, to those of that variety with one axis, which seems to form the central portion and upper lamina of Dr Brewster's *Tesselite*, and of which I need not here particularise the succession of colours, as it is given at full length in my paper above alluded to. On the other hand, the rings in the thinner portion exhibited a complete inversion of the Newtonian Scale, the red rays being more energetically acted upon than the violet, and that to so extraordinary a degree, that the whole prismatic spectrum was displayed in the very first ring.

To obtain a sufficient range of incidence, this plate was inclosed in olive oil, in a proper apparatus for measuring the inclination, and being exposed to polarized light, (the plane of incidence 45° inclined to that of primitive polarization,) the succession of tints, and their corresponding angles of incidence were as in the following Table, in which the angles are deduced from two observations of the same tint on opposite sides of the axis. The measures of length in this and the subsequent pages are in millionths of an inch, for the sake of placing in evidence their proportion to the lengths of the fits of easy transmission and reflexion.

TABLE II.—*Second variety of Apophyllite in olive oil. Index of refraction* 1.0497. *Thickness of the plate* = 94499.

Incidence.	Ordinary Pencil.	Extraordinary Pencil.
0° 0'	White.	Black.
	White.	Sombre orange-red.
	White.	Pretty good orange.
	Very light blue.	Good orange-yellow.
	Sky-blue.	Fine orange-yellow.
	Fine deep indigo.	Fine light yellow.
23 35	Rich dark purple.	Pale yellow.
	Fine crimson.	Light greenish-yellow.
27° 11'	Fine pink.	Fine light green.
28 48	Pink, somewhat inclining to brick-red.	Good bluish-green (*maximum* of contrast).
	Light pink, inclining to orange.	Blue, rather greenish.
	Pale pink yellow.	Dirty and sombre blue.
33 2	Yellowish-white.	Dull, indifferent purple.

TABLE II.—*Continued.*

Incidence.	Ordinary Pencil.	Extraordinary Pencil.
	Light yellow green.	Good pink.
36° 48′	Good bluish-green.	Good pink inclining to brick-red.
	Dull blue green.	Orange pink.
	Very dull blue green.	Yellow pink.
39 41	Pale purple, almost white.	Pale yellow, almost white.
41° 35′	Pink, inclining to brick-red.	Bluish-green, rather pale.
	Yellow pink.	Dull pale blue.
43 55	White.	Very dilute purple.
46° 37′	Pale blue green.	Pale pink.
	White.	White.
50° 2′	Very pale pink.	Very pale blue.
	White.	White.

Beyond this inclination, the colours are no longer distinguishable. The whole series indicates a separation of the colours much more considerable than in the Scale of Newton; but to examine the variation of the polarizing energy for the several simple colours more minutely, we must have recourse to homogeneous light. The requisite measures were taken with every precaution in very fine sunshine, and though, owing to the imperfections of the specimen, they do not pretend to great precision, the resulting numbers can scarcely be erroneous to the extent of $\frac{1}{15}$ or $\frac{1}{20}$ of their own value. I think it necessary to premise this, as the law of action indicated by the following Table of the results is so very surprising and unexpected, that it was not without scrupulous examination I could persuade myself that no enormous oversight had been committed. The first column expresses the colour of the incident ray, the second the length of the shortest period of alternate polarization it is capable of performing within the crystal, computed by M. Biot's formula, $l = t. \frac{\sin \theta. \tan \theta}{n}$, in which t represents the thickness of the plate, θ the angle an intromitted ray makes with the axis (supposed perpendicular to the surface), n the number of periods and parts of a period it executes during its passage through the plate, or the order of the ring to which it is referred at its egress, and l the length of a period performed by the same ray, supposed to traverse the crystal at right angles to its axis, or the minimum length above mentioned. The third column contains the value of $\frac{1}{l}$, which measures the polarizing energy of the crystal on that particular ray; the last the number of observations employed in computing the values in the preceding.

TABLE III. *Representing the Law of Action of the Second Variety of Apophyllite, on the differently coloured Rays of the Spectrum.*

Name of Colour.	Value of l.	Value of $\frac{1000000}{l}$.	Number of Observations.
Extreme red.	20213	49.475	20
Mean orange.	25465	39.270	20
—— yellow.	30374	32.923	20
—— green.	38057	26.277	20
—— blue.	93904	10.649	10
—— indigo.	250000 +	4.000 —	—
Indigo violet.	250000 +	4.708 —	—
Mean violet.	45992	21.143	2
Extreme violet.	35043	28.536	13

By this Table we see that the action of the crystal decreases rapidly, but regularly enough, from the extreme red to the blue rays, when it sinks all on a sudden, and throughout the whole extent of the indigo and first portions of the violet is so small, that I was unable to obtain a measure even of the first ring at its *maximum*, within the range of incidence my apparatus would admit. It then increases again, more suddenly than it fell, and for the extreme violet has a value intermediate between those for the yellow and green. If we construct a curve *r o y g b i v*, Plate VII. Fig. 14. whose abscissas *AR*, *AO*, &c. are reciprocally proportional to the lengths of the Newtonian fits, and drawing the line *A r B* at an angle of 45° with *AV*, take the ordinates *R r*, *O o*, &c. every where proportional to the value of $\frac{1000000}{l}$ in this Table, this curve will represent the action of this variety of apophyllite on the whole spectrum, while *r B* represents that of a crystal whose tints follow the Scale of Newton.

This is in perfect agreement with the succession of tints given above. If we cast our eye over it, a deficiency of the indigo rays is perceived in all the scale of the extraordinary pencil, no pure or rich blue occurring throughout its whole extent. In the ordinary pencil, on the other hand, the excess of indigo appears immediately in the rich tints of indigo, purple and crimson, which occur in the first order. The yellow rays, too, afford us a numerical verification of the number assigned to them. The *maxima* and *minima* of these coincide, as Newton has observed, with the most luminous, and obscurest parts of the rings, which is a necessary consequence of their great illuminating power. Now these occur at the incidences 23° 35′, 33° 2′, and 39° 41′ respectively; and if we compute the angles of refraction (θ) corresponding to these, and take n successively $\frac{1}{2}$, 1, $\frac{3}{2}$, the formula already employed gives

by the first *maximum*	- -	$l = 29269$
by the first *minimum*	- -	$l = 29822$
by the second *maximum*	-	$l = 29370$
		$l = 29487$ Mean.

which differs from the result in the third Table by less than $\frac{1}{23}$ of its value.

The absolute polarizing powers of the two portions into which the crystal was divided, differed no less remarkably than the characters of their tints. In the thicker plate, by a mean of 20 careful observations made by the interposition of a certain standard red glass, on the ring of the third order at its *minimum*, (in which the evanescence of the extraordinary pencil was complete,) I found 37° 3′ for its apparent semi-diameter in air; and hence we find $\theta = 23° \ 7'$, $n = 3$, $t = 165900$, which substituted give

$$l = 9269; \ \frac{1000000}{l} = 107.886,$$

and, (as is sufficiently evident from the scale of tints in this portion,) the value of l is nearly the same for all the other colours. Now it is well worthy of observation, that this value coincides almost precisely with the number similarly determined for the variety examined in my paper above alluded to, which I have there found to 9281. The difference is little more than $\frac{1}{1000}$ of the whole, and so exact an agreement could hardly have been expected even in plates detached from the same specimen. This circumstance, together with the identity in the scale of tints exhibited by the two substances, establishes not only their exact similarity as individuals, but, what is of much more importance in this case, the definite nature of the variety itself;

and at the same time proves that in detaching the two portions from one another, no part of the second variety remained adhering to the first, as it must have become sensible by enfeebling the polarising power, if not by altering the tints.

(To be concluded in next Number.)

Art. XVI.—*On the Antiseptic Power of the Pyrolignous Acid upon Fresh Meat, subjected to a Sea Voyage and a Hot Climate.* By J. Stanley, M.D. In a Letter to Dr Brewster.

As I am not aware that any experiments have as yet been published, wherein meat preserved by means of the pyrolignous acid was subjected to the test of a sea voyage and a hot climate, I have taken the liberty of sending you an account of the following trial, if you deem it worth your notice.

Having previously made several experiments with the above named acid, the results of which were favourable, on the 6th of October 1819, I prepared two pieces of fresh meat (beef) with the purified acid, applying it lightly over their surfaces by means of a small brush. After hanging up in my kitchen till the 12th of November following, I gave one of the specimens to the captain of a vessel bound for the West Indies, with directions to observe and note any change that might take place during his voyage, and to bring it back to me on the return of his ship to port. In the month of October 1820 he restored me the specimen. He had examined it several times on the voyage out, and during his stay of some months at the Island of Tobago, as did several gentlemen resident there, but no perceptible change could be detected. On comparing it with the specimen kept at home, I could observe no sensible difference in their appearance. On the 21st December following, I caused both to be thoroughly boiled, and, when served up, they were declared by several gentlemen who tasted them with me, to be perfectly fresh and sweet, and, with the addition of salt and vegetables, a palatable and wholesome dish.

The above experiment I think fully proves the antiseptic powers of the pyrolignous acid, my specimens having been preserved for the space of fourteen months, and one of them subjected to a long sea voyage, and the action of a West India climate, with success.

I have, for the purpose of verifying the foregoing experiment, again prepared two specimens, the one mutton and the other beef, and sent them out to the same island, with similar directions, and I make no doubt of the result being equally satisfactory. I remain, &c. J. Stanley.

Whitehaven, *Feb.* 7. 1821.

Art. XVII.—*Notice of the Voyage of Edward Barnsfield, Master of his Majesty's Ship Andromache, to New South Shetland* *.

About a twelvemonth ago, an English merchant brig, in performing a voyage to this port, made what they supposed to be land, several degrees to the southward of Cape Horn, and in a situation in which it is positively asserted that no land *can* exist. From the difference in opinion of those on board the vessel, and, from some other circumstances, little credit was attached to it at that time; but the master being fully convinced that what had been seen was actually land, determined to put it beyond a doubt, should he come round again. He accordingly made the land again last October, and having sailed along it for some considerable distance, he returned about the beginning of December to this port, and laid before the Naval Commander in Chief here, such charts and views, as induced him to hire the same brig on account of Government, to complete the discovery. The command of the expedition was given to Mr Edward Barnsfield, master of H. M. S. Andromache, with three midshipmen from the same ship, to assist him in his nautical researches; and as it was deemed necessary to send a medical officer, I went as a volunteer on the occasion. We sailed from Valparaiso on the 20th of December 1819, but did not arrive on cruising ground till the 16th of January 1820, having been almost constantly harassed with baffling winds and calms till we arrived in a high southern latitude. On that day, however, we had the good

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* See this *Journal*, vol. III. p. 367. particularly p. 374. and Plate XII. of that volume.

fortune to discover the land to the south-eastward, extending on both bows as far as the eye could reach. At a distance, its limits could scarcely be distinguished from the light white clouds which floated on the tops of the mountains. Upon a nearer approach, however, every object became distinct. The whole line of coast appeared high, bold, and rugged; rising abruptly from the sea in perpendicular snowy cliffs, except here and there where the naked face of a barren black rock shewed itself amongst them. In the interior, the land, or rather the snow, sloped gradually and gently upwards into high hills, which appeared to be situated some miles from the sea. No attempt was made to land here, as the weather became rather threatening, and a dense fog came on, which soon shut every thing from our view at more than a hundred yards distance. A boat had been sent away in the mean time to try for anchorage; but they found the coast completely surrounded by dangerous sunken rocks, and the bottom so foul, and the water so deep, that it was not thought prudent to go nearer the shore in the brig, especially as it was exposed to almost every wind. The boat brought off some seals and penguins which had been shot among the rocks; but they reported them to be the only animated objects they had discovered. The latitude of this part of the coast was found to be 62° 26′ S. and its longitude to be 60° 54′ W. (See Vol. III. of this Journal, Plate XII. Fig. 2.)

Three days after this, we discovered and anchored in an extensive bay, about two degrees farther to the eastward, where we were enabled to land, and examine the country. Words can scarcely be found to describe its barrenness and sterility. Only one small spot of land was discovered on which a landing could be effected upon the Main, every other part of the bay being bounded by the same inaccessible cliffs which we had met with before. We landed on a shingle beach, on which there was a heavy surf beating, and from which a small stream of fresh-water ran into the sea. Nothing was to be seen but the rugged surface of barren rocks, upon which myriads of sea-fowls had laid their eggs, and which they were then hatching. These birds were so little accustomed to the sight of any other animal, that, so far from being intimidated by our approach, they even disputed our landing, and we were obliged forcibly to open a passage for ourselves through them. They consisted principally of four species of the penguin; with albatrosses, gulls, pintadoes, shags, sea-swallows, and a bird about the size and shape of the common pigeon, and of a milk-white plumage, the only species we met with that was not web-footed. We also fell in with a number of the animals described in Lord Anson's voyage as the Sea-Lion, and said by him to be so plentiful at Juan Fernandez, many of which we killed. Seals were also pretty numerous; but though we walked some distance into the country, we could observe no trace either of inhabitants, or of any terrestrial animal. It would be impossible, indeed, for any but beasts of prey to subsist here, as we met with no sort of vegetation except here and there small patches of stunted grass growing upon the surface of the thick coat of dung which the sea-fowls left in the crevices of the rocks, and a species of moss, which occasionally we met with adhering to the rocks themselves. In short, we traced the land nine or ten degrees east and west, and about three degrees north and south, and found its general appearance always the same, high, mountainous, barren, and universally covered with snow, except where the rugged summits of a black rock appeared through it, resembling a small island in the midst of the ocean; but from the lateness of the season, and the almost constant fogs in which we were enveloped, we could not ascertain whether it formed part of a continent, or was only a group of islands. If it is insular, there must be *some* of an immense extent, as we found a gulf nearly 150 miles in depth, out of which we had some difficulty in finding our way back again.

The discovery of this land must be of great interest in a geographical point of view, and its importance to the commercial interests of our country, must be evident from the very great numbers of whales with which we were daily surrounded; and the multitudes of the finest fur-seals and sea-lions which we met both at sea and on every point of the coast, or adjacent rocky islands, on which we were able to land. The fur of the former is the finest and longest I have ever seen; and from their having now become scarce in every other part of these seas, and the great demand for them both in Europe and India, they will, I have no doubt, become, as soon as the discovery is made public, a favourite speculation amongst our merchants. The oil procured from the sea-lion is, I am told, nearly equal in value to that of the spermaceti whale. And the great number of whales we saw every where near the land, must also be an important thing to our merchants, as they have lately been said to be very scarce to the northward.

We left the coast on the 21st of March, and arrived at this place on the 14th of April, having touched at Juan Fernandez for refreshment.

H. M. S. SLANEY,
VALPARAISO, *26th May* 1820.

ART. XVIII.—*Observations on the Diurnal Variation of the Needle from* 1775 *to* 1780, *at Zwanenburg in Holland.*

THE following very valuable table of the diurnal variation of the magnetic needle, at Zwanenburg in Holland, has been obligingly communicated to me by Colonel Beaufoy, who received it from our learned correspondent Mr Charles Rumker, Director of the Nautical Academy of Hamburgh. We are not acquainted either with the name of the observer, or with the nature of the apparatus by which the variation was determined; but we shall be able, in a subsequent Number, to communicate this information to our readers. D. B.

Year.	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1775,						Morn.			21°39	21°38	21°29	21°33
1776,	21°.38	21°.36	21°.38	22°.3	22°.3	22°.0	22°.1	21°.57	21.28	21.17	21.9	21.40
1777,	21.37	21.48	21.45	21.51	21.49	22.19	21.54	22.6	22.30	22.40	22.18	21.54
1778,	22.1	21.45	21.48	21.54	22.17	23.2	23.2	22.59	23.4	22.53	22.32	22.40
1779,	22.42	22.11	22.14	22.47	22.39	22.35	22.34	22.42	22.39	22.42	22.42	22.41
1780,	22.33	22.31	22.33	22.37	22.32	22.33	22.33	22.24	22.33	22.35	22.37	22.36
1775,						Noon.			21.43	21.43	21.30	21.37
1776,	21.39	21.37	21.47	22.12	22.9	22.5	22.6	22.6	21.38	21.24	21.18	21.44
1777,	21.41	21.54	21.50	21.54	21.53	22.23	21.57	22.11	22.32	22.41	22.19	21.58
1778,	22.3	21.47	21.50	21.58	22.20	23.2	23.3	23.00	23.5	22.53	22.33	22.37
1779,	22.46	23.13	23.13	22.49	22.39	22.35	22.35	22.43	22.40	22.43	22.43	22.40
1780,	22.33	22.32	22.35	22.37	22.32	22.34	22.34	22.24	22.34	22.36	22.38	22.37
1775,						Even.			21.39	21.41	21.27	21.35
1776,	21.37	21.35	21.40	22.6	22.8	22.4	22.3	22.1	21.32	21.19	21.10	21.42
1777,	21.38	21.47	21.44	21.52	21.50	22.41	21.55	22.10	22.30	22.38	22.17	21.56
1778,	22.00	21.45	21.47	21.55	22.19	23.0	23.1	22.59	22.51	23.3	22.32	22.36
1779,	22.45	23.12	23.11	22.48	22.38	22.34	22.33	22.41	22.39	22.42	22.42	22.39
1780,	22.31	22.30	22.34	22.37	22.32	22.34	22.33	22.23	22.33	22.34	22.36	22.35

Art. XIX.—*Notice regarding the Working and Polishing of Granite in India.* By Alexander Kennedy, M. D. F. R. S. Edin. Communicated by the Author *.

THE following observations have been suggested by the very excellent paper upon the Temples of Thebes, lately read by Colonel Straton in this Society. In that paper, he had occasion to mention the very high polish still retained by the granite statues, columns, and other remains of Egyptian antiquity; and in illustration of the great hardness of the material of which these are formed, he noticed incidentally the difficulty which had been found in operating upon one of these granite statues now in the British Museum, and the number of tools which had been broken in the process of replacing one of its arms.

That the arts, as well as the religion of the Hindoos, were originally derived from the Egyptians, seems not to admit of any doubt; and among the arts now practised by the Hindoos, that of working and polishing granite, has, in all probability, undergone no change from the period of its first introduction among them. Most probably, therefore, the processes may be the very same as those by which the materials of the stupendous temples of Egypt were prepared and finished; and as the subject thus acquires an additional degree both of curiosity and interest, I shall subjoin some notices of the manner in which I have seen the hardest granite cut and polished by Hindoo workmen.

The only tools which they employ, are a small steel chisel and an iron mallet. The chisel is short, probably not longer than twice the breadth of the small hands which work with it †. I think it most probable that each of these chisels may be formed of one of the short bars of Berar wootz, described by Dr Heyne in his Tracts on India; but this is merely conjecture. The chisel tapers to a round point like that of a drawing pencil; and this I believe to be the only shape ever given to the points of their chisels.

* Read before the Royal Society Feb. 19. 1821.

† The smallness of the handle of the Hindoo sword has often been remarked.

The mallet, I have said, is of iron. It is somewhat longer than the chisel: its weight cannot exceed a few pounds. The head, set on at right angles to the handle, may be from two to three inches long. It has only one striking face, in this respect resembling the hammer by which the bell of a clock is struck. The striking face is formed into a pretty deep hollow, which is lined with lead, no doubt to deaden the blow, when these two instruments come in contact.

With two such simple tools, to detach the most massy granite column from its native bed *, to have formed, fashioned, and scarped the granite rock which forms the tremendous fortress of Dowlatabad †, and to have excavated the wonderful caverns at Ellora, are instances both of the incredible patience and perseverance of the Hindoo, and of the simple and apparently inadequate means by which he accomplishes the most difficult undertakings; for it seems by no means probable that the Hindoo stone-cutters ever worked with any other tools. Accordingly, the traces of the pointed chisel, are at this day as fresh upon the rock of the very ancient fortress of Dowlatabad, as when first cut. Are not traces of the pointed chisel to be seen upon the granite antiquities of Egypt?

Having by these two instruments only, brought the stone to a smooth surface, it next undergoes the dressing with water, in the manner usual with masons. It now only remains to apply the black shining polish, which is done as follows.

A block of granite, of considerable size, is rudely fashioned into the shape of the end of a large pestle. The lower face of this is hollowed out into a cavity, and this is filled with a mass composed of pounded corundum-stone, mixed with melted bees-wax. This block is moved by means of two sticks, or pieces of bamboo, placed one on each side of its neck, and bound together by cords, twisted and tightened by sticks. The weight of the

* An obelisk of a single granite stone, the shaft of which, as I am credibly informed, is seventy-five feet in length, was erected a few years ago in the neighbourhood of Seringapatam, to the memory of the late Josiah Webbe, Esq. It was quarried in that neighbourhood, and the whole work executed by Hindoo workmen.

† See a very correct Plate of it in Captain Fitzclarence's Travels.

whole is as much as two workmen can easily manage. They seat themselves upon, or close to the stone they are to polish, and, by moving the block backwards and forwards between them, the polish is given by the friction of the mass of wax and corundum.

Granite finished in this way, is the most common material of which the tomb-stones of princes and great men in India are constructed. As a beautiful glossy black, it is scarcely if at all inferior to the finest black marble; and, referring both to ancient Indian monuments *, and to the observations of Colonel Straton, it would appear that the polish thus given to granite, may be said to be as imperishable, as the material itself to which it is applied.

I had an opportunity of making these observations while engaged in erecting a granite monument, ornamented with black pilasters. The workmen succeeded most perfectly in giving the black polish to the granite, in the manner I have described.

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* In the end of the year 1794, I had an opportunity of visiting the ancient city of Warankul, and of seeing a granite gateway, standing within the bounds of the palace, the fine black polish of which appeared to have lost nothing of its original lustre. It was almost the only remains of the royal residence, and we were told had been originally one of four similar gates which led into a court in the interior of the palace. The other three had been removed for the sake of the materials. This beautiful gateway deserves also to be mentioned for the very durable manner in which it was constructed. The stones were fitted to each other most accurately, so that the joinings were as close as those of a modern marble chimney-piece; and as no mortar, nor cement of any kind, had been employed, it seemed perfectly secure, both against the attacks of vegetation and the influences of the weather. But for these circumstances, it could not have escaped being attacked by the seeds of the banyan-tree, and would probably have been entirely subverted long before the time of my seeing it. On the contrary, it seemed quite secure from the attacks of this irresistible enemy of Indian architecture, and was in every respect so perfectly fresh, that, unless by the application of external force, it seemed to be capable of lasting for ever.

According to Colonel Wilkes, the city of Warankul was founded A. D. 1067, and captured by the Delhi Patans in 1323, when the dynasty was subverted. The gateway in question could therefore scarcely have been less than 500 years old, and might probably have been considerably older.

Art. XX.—*Account of the Native Hydrate of Magnesia, discovered by Dr* Hibbert *in Shetland.* By David Brewster, LL.D., F.R.S. Lond. & Sec. R. S. Edin.*

The Native Hydrate of Magnesia was first discovered and ranked as a separate mineral by the late Dr Bruce of New York. It was found only at Hoboken in New Jersey, traversing serpentine in all directions, in veins of from a few lines to two inches in thickness. Its specific gravity was 2.13, and it yielded, upon analysis, 70 parts of pure magnesia, and 30 of water †.

In the year 1813, I received some fragments of this rare mineral from our late eminent countryman Dr John Murray, and though it exhibited no traces of a crystalline structure, I found it to be a regularly crystallised mineral, with One axis of double refraction perpendicular to the laminæ ‡. The connection between the primitive form of minerals and their number of axes of double refraction, which I observed at a subsequent period, enabled me to determine that the native hydrate of magnesia belonged either to the *Rhomboidal* or the *Pyramidal* system of Mohs.

In this state of our information respecting native magnesia, Dr Hibbert, (who has distinguished himself by his excellent mineralogical survey of Shetland, and augmented our national resources by the discovery of chromate of iron in large quantities), put into my hands a mineral from Shetland, which had been considered by mineralogists as *White Talc*, but which he was persuaded differed materially in the nature of its ingredients from that substance. In consequence of being familiar with the Hoboken magnesia, I considered the Shetland specimen as the same mineral, and I put this opinion beyond a doubt, by establishing the identity of their optical properties, and also by a chemical examination of the two substances.

Mineralogical Character.—The structure of native hydrate of magnesia is distinctly lamellar. The laminæ sometimes di-

* From the *Transactions of the Royal Society of Edinburgh*, vol. ix. p. 239.

† See Bruce's *American Mineralogical Journal*, vol. i. p. 26.—30.

‡ See *Phil. Trans.* 1814, p. 213, and 1818, p. 211.

verge from a central line, and frequently occur in groups, with the laminæ of one group inclined to those of another, like the masses of mica in granite.

The colour of the laminæ is white, and a slight tinge of green is sometimes observed, when we look upon their edges. They are perfectly transparent when separate; but I have noticed in specimens exposed to the weather, a dull and white opacity, which had been induced by the separation of the mineral into a greater number of minute laminæ. This white part has the same relation to the transparent part as *Albin* has to *Apophyllite*, (see *Edin. Phil. Journal*, vol. i. p. 5.) and, as happens with this mineral, the disintegration follows the crystalline structure of the body. One specimen of this kind exhibited a six-sided prism, the interior of which was undecomposed, while all the external part had a white opacity.

The Native Hydrate of Magnesia scratches *Talc*, from which it may be easily distinguished, as the former marks white paper with a silvery powder, whereas the latter gives only a polished line, and leaves none of its own substance. Its hardness seems to be 1.5.

In several specimens I have observed a distinct crystalline structure in the form of the regular hexahedral prism. The pyramidal form being therefore excluded, it will belong to the *Rhomboidal* system of Mohs.

Its specific gravity is 2.336. It adheres very slightly to the tongue; and it will constitute a new Genus of the 5th Order, or that of Mica, in the 2d Class of Mohs' System, unless the order of *Talc-Mica* be modified to receive it.

Locality.—Dr Hibbert found this substance, in 1817, at Swinaness, in Unst, one of the Shetland Isles, traversing serpentine in all directions, being mixed with the magnesian carbonate of lime, and forming veins from half an inch to six or eight inches broad.

Chemical Character.—Hydrate of Magnesia dissolves entirely in muriatic, nitric, and dilute sulphuric acids; and I obtained from its solutions in muriatic and sulphuric acids, the deliquescent salt of *Muriate of Magnesia* and regular crystals of *Sulphate of Magnesia.* On some occasions a very slight effervescence takes place; but this no doubt arises from adhering particles of carbonate of lime, or from a small quantity of carbonic acid, which may have been absorbed by exposure to the atmosphere.

The following analysis of this mineral has been made by Dr Fyfe, since the preceding account of it was drawn up *.

Magnesia,	-	-	69.75
Water,	-	-	30.25
			100.00

a result which differs only a quarter of a *per cent.* from that of Dr Bruce of New York.

Optical Structure.—The Native Magnesia has *One* axis of double refraction perpendicular to the laminæ, and exhibits the single system of coloured rings, traversed by a black cross. The character of its action is *Positive*, like that of *Quartz*, and the tints which it polarises are different from those of Newton's scale, resembling somewhat those which surround the resultant axes of Selenite †. This mineral is not phosphorescent by heat.

Distinctive Character.—The Hydrate of Magnesia is distinguished from *Talc*, by its having One axis of double refraction, while *Talc* has Two axes;—by its lower specific gravity, and greater hardness;—by its marking paper with a polished line, in place of a silvery one, as already noticed; and by its solubility in acids. It is distinguished from the *Common Mica* with two axes, by the elasticity of the latter, as well as by its two axes; and it is equally distinguished from the less flexible *Mica of Kariat of Greenland*, and from other Micas that have only one axis, by that axis being positive in the *Magnesia* and negative in the *Mica*, and also by the character of the tints with which the axis is encircled.

It is distinguished from *Selenite*, by its having one axis of double refraction perpendicular to the laminæ, whereas *Selenite*

* Dr Fyfe analysed also a very small portion of the Hydrate of Magnesia from Hoboken, which I had used in my optical experiments, and found it to consist of 68.57 of Magnesia, and 31.43 of Water, with a trace of Lime. In some of Dr Hibbert's specimens, Dr Fyfe obtained 0.5 of Lime and Iron, and 4.4 of Carbonic Acid, which, however, issued only from particular points of the fragment.

† See *Phil. Trans.* 1818, p. 243.

has two resultant axes lying in the plane of the laminæ;—by the want of regular cleavages,—and by its solubility in acids.

ART. XXI.—*Experiments on the Going of a Clock with a Wooden Pendulum.* By Colonel BEAUFOY, F. R. S. &c. &c. In a communication to Dr BREWSTER.

IN order to determine what reliance could be placed on the going of a clock with a wooden pendulum, I fitted one of my monthly regulators, beating dead seconds, and whose motion continued whilst winding up, with a straight-grained cylindrical deal-rod; but being dissatisfied with the irregularity of the rate, I was on the point of abandoning this, when, from the circumstance of the clock becoming much out of beat, I concluded that the great source of error might probably proceed from the warping of the wood. I therefore caused the intermediate portion of the deal, about an inch below that part where the watch-spring which suspends the pendulum is fastened to the upper part of the bob, to be reduced from a cylindrical to an elliptical shape, the transverse or longest diameter being parallel to the back of the clock. This alteration so much improved the going, that I am induced to trouble you with a Table containing the rate for 24 months, and to remark, that the rod was perforated in the centre for the crutch to pass through, and a brass eye inserted to prevent the wearing away of the wood. To render the pendulum steady, it was hung independent of the frame that supports the clock; and the bob, in lieu of being screwed to the rod, was permitted to rest upon a divided nut, turning on a fine screw, attached to the lower extremity of the rod, and which answered the twofold purpose of supporting this weight, and regulating the pendulum. The advantage of permitting the bob to remain unconfined to the rod, is, that the expansion of the bob upwards has a tendency to counteract the expansion of that spring by which the pendulum is hung downwards, and of therefore preserving the same length. By examining the Tables, it will be found, that the accuracy of the simple pendulum described, is little inferior to the compound one known by the name of the *Gridiron Pendulum;* and when it is considered that the latter costs 12 guineas, and the rod not as many pence, the variation of the going bears so small a proportion to the difference of price, that it will, generally speaking, be sufficiently accurate for most purposes.

TABLE,—Rate of a Clock with a Wooden Pendulum.

Date.	Clock Fast or Slow.	Differences.	Daily Rate.	Date.	Clock Fast or Slow.	Differences.	Daily Rate.
1819,	′ ″			1819,	′ ″	″	″
Jan. 31.	—0.10.40	″	″	July 28.	—1.54.38	0.06	+ 0.03
Feb. 6.	—0.02.07	8.33	—1.39	29.	—1.54.90	0.52	—0.52
10.	—0.03.37	5.44	—1.36	31.	—1.56.38	1.48	—0.74
13.	—0.07.91	4.54	—1.51	Aug. 3.	—1.55.09	1.29	—0.43
20.	—0.18.55	10.64	—1.52	7.	—1.58.41	3.32	—0.83
25.	—0.23.47	4.92	—0.98	10.	—2.01.05	2.64	—0.88
Mar. 4.	—0.30.45	6.98	—0.99	14.	—2.03.39	2.34	—0.59
9.	—0.38.00	7.55	—1.51	21.	—0.07.80	4.41	—0.63
14.	—0.46.00	8.00	—1.60	* 25.	—0.10.88	3.08	—0.77
18.	—0.50.17	4.17	—1.04	26.	—0.09.75	1.13	+ 1.43
22.	—0.50.67	0.50	—0.13	27.	—0.09.53	0.22	+ 0.91
24.	—0.50.25	0.42	+ 0.21	28.	—0.09.83	0.30	—0.30
26.	—0.50.32	0.07	—0.03	31.	—0.07.14	2.69	+ 0.89
29.	—0.50.10	0.22	—0.07	Sept. 2.	—0.07.95	0.81	—0.40
April 1.	—0.52.02	1.92	—0.64	6.	—0.06.34	1.61	+ 0.40
3.	—0.53.86	1.84	—0.92	9.	—0.08.55	2.21	—0.74
5.	—0.54.20	0.34	—0.17	13.	—0.08.84	0.29	—0.07
7.	—0.54.34	0.14	—0.07	17.	—0.11.67	2.83	—0.71
10.	—0.55.05	0.71	—0.24	19.	—0.10.33	1.84	+ 0.67
15.	—0.57.22	2.17	—0.43	21.	—0.10.75	0.42	—0.21
27.	—1.08.06	10.84	—0.90	23.	—0.08.55	2.20	+ 1.10
29.	—1.08.73	0.67	—0.34	Oct. 1.	—0.20.05	11.50	—1.44
May 1.	—1.08.61	0.12	+ 0.04	4.	—0.18.01	2.04	+ 0.68
4.	—1.06.07	2.54	+ 0.85	9.	—0.18.25	0.24	—0.05
7.	—1.04.37	1.70	+ 0.57	12.	—0.21.38	3.13	—1.04
9.	—1.03.77	0.60	+ 0.30	14.	—0.23.57	2.19	—1.09
12.	—1.01.40	2.37	+ 0.79	16.	—0.24.03	0.46	—0.23
14.	—1.01.70	0.30	—0.25	18.	—0.24.10	0.07	—0.04
17.	—1.00.15	1.55	+ 0.52	22.	—0.21.90	2.20	+ 0.55
22.	—1.58.70	1.45	+ 0.29	27.	—0.18.58	3.32	+ 0.66
28.	—0.01.64	2.94	—0.49	Nov. 3.	—0.16.60	1.98	+ 0.28
June 5.	—1.00.81	0.83	+ 0.10	6.	—0.17.22	0.62	—0.21
7.	—1.02.00	1.19	—0.59	10.	—0.16.50	0.72	+ 0.18
9.	—1.02.85	0.85	—0.42	12.	—0.15.66	0.84	+ 0.42
16.	—1.04.98	2.13	—0.30	21.	—0.15.56	0.10	+ 0.01
19.	—1.07.96	2.98	—0.99	23.	—0.13.53	2.03	+ 1.02
21.	—1.10.62	2.66	—1.33	† 26.	+ 1.02.58	—	—
30.	—1.19.32	8.70	—0.97	Dec. 3.	+ 0.59.20	3.38	—0.48
July 3.	—1.22.70	3.38	—1.13	8.	+ 0.57.58	1.62	—0.32
7.	—1.29.72	7.02	—1.75	11.	+ 0.57.08	0.50	—0.17
17.	—1.43.54	13.82	—1.38	13.	+ 0.57.87	0.79	+ 0.49
19.	—1.45.50	1.96	—0.98	22.	+ 0.47.60	10.27	—1.14
22.	—1.50.68	5.18	—1.73	24.	+ 0.47.16	0.44	—0.22
23.	—1.50.91	0.23	—0.23	27.	+ 0.47.47	0.31	+ 0.10
25.	—1.53.05	2.14	—1.07	30.	+ 0.48.07	0.60	+ 0.20
26.	—1.54.44	1.39	—1.39	31.	+ 0.48.74	0.67	+ 0.67

* Aug. 14. Clock put forward two minutes.

† Nov. 25, Clock taken to pieces and cleaned.

Date.	Clock Fast or Slow.	Differences.	Daily Rate.	Date.	Clock Fast or Slow.	Differences.	Daily Rate.
1820,	′ ″	″	″	1820,	′ ″	″	″
Jan. 3.	+ 0.49.11	0.37	+ 0.12	July 31.	+ 3.00.32	0.52	— 0.26
5.	+ 0.48.45	0.66	— 0.33	Aug. 2.	+ 3.00.25	0.07	— 0.04
8.	+ 0.49.16	0.71	+ 0.24	4.	+ 3.01.12	0.87	+ 0.44
15.	+ 0.48.84	0.32	— 0.05	7.	+ 3.01.32	0.20	+ 0.06
22.	+ 0.45.94	2.90	— 0.41	9.	+ 3.01.85	0.53	+ 0.26
31.	+ 0.37.72	8.22	— 0.96	10.	+ 3.02.09	0.24	+ 0.24
Feb. 9.	+ 0.33.64	4.08	— 0.45	12.	+ 3.02.17	0.08	+ 0.04
17.	+ 0.32.84	0.80	— 0.10	14.	+ 3.03.51	1.34	+ 0.67
21.	+ 0.35.99	3.15	+ 0.79	15.	+ 3.04.19	0.68	+ 0.68
27.	+ 0.36.75	0.76	+ 0.13	18.	+ 3.03.92	0.27	— 0.09
29.	+ 0.37.37	0.62	+ 0.31	20.	+ 3.05.24	1.32	+ 0.66
Mar. 4.	+ 0.38.69	1.32	+ 0.33	29.	+ 3.11.42	6.18	+ 0.68
8.	+ 0.41.17	2.48	+ 0.64	Sept. 2.	+ 3.14.78	3.36	+ 1.12
13.	+ 0.45.10	3.93	+ 0.79	4.	+ 3.15.58	0.80	+ 0.40
18.	+ 0.45.32	0.22	+ 0.04	5.	+ 3.16.17	0.59	+ 0.59
22.	+ 0.48.23	2.91	+ 0.73	8.	+ 3.20.19	4.02	+ 1.34
24.	+ 0.51.94	3.71	+ 1.85	11.	+ 3.19.91	0.28	— 0.09
25.	+ 0.54.13	2.19	+ 2.19	13.	+ 3.20.09	0.18	— 0.09
28.	+ 0.59.43	5.30	+ 1.77	14.	+ 3.20.07	0.02	— 0.02
30.	+ 1.00.58	1.15	+ 0.57	19.	+ 3.23.70	3.63	+ 0.73
April 4.	+ 1.06.18	5.60	+ 1.12	21.	+ 3.27.09	3.39	+ 1.70
7.	+ 1.12.99	6.81	+ 2.27	27.	+ 3.30.21	3.12	+ 0.52
15.	+ 1.32.39	9.40	+ 1.55	30.	+ 3.30.52	0.31	+ 0.10
19.	+ 1.22.83	0.44	+ 0.11	Oct. 2.	+ 3.30.37	0.15	— 0.07
21.	+ 1.24.70	1.87	+ 0.93	6.	+ 3.32.54	2.17	+ 0.54
23.	+ 1.28.05	3.35	+ 1.67	7.	+ 3.31.52	1.02	— 1.02
25.	+ 1.31.38	3.33	+ 1.66	11.	+ 3.33.89	2.37	+ 0.59
28.	+ 1.39.69	8.31	+ 2.77	12.	+ 3.34.00	0.11	+ 0·11
May 1.	+ 1.48.04	8.35	+ 2.78	16.	+ 3.35.05	1.05	+ 0.26
6.	+ 2.03.12	15.08	+ 3.02	18.	+ 3.35.36	0.31	+ 0.16
9.	+ 2.10.65	7.53	+ 2.51	25.	+ 3.36.67	1.31	+ 0.19
15.	+ 2.20.00	9.35	+ 1.56	28.	+ 3.36.01	0.66	— 0.13
17.	+ 2.22.37	2.37	+ 1.18	Nov. 2.	+ 3.32.95	3.06	— 0.61
21.	+ 2.27.11	4.74	+ 1.18	4.	+ 3.31.28	1.67	— 0.84
22.	+ 2.28.12	1.01	+ 1.01	7.	+ 3.28.45	2.83	— 0.94
23.	+ 2.28.73	0.61	+ 0.61	12.	+ 3.21.69	6.76	— 1.35
27.	+ 2.33.78	5.05	+ 1.26	15.	+ 3.19.36	2.33	— 0.78
30.	+ 2.37.85	4.07	+ 1.36	18.	+ 3.16.60	2.76	— 0.92
June 3.	+ 2.42.64	4.79	+ 1.19	26.	+ 3.06.58	10.02	— 1.25
5.	+ 2.45.19	2.55	+ 1.26	Dec. 1.	+ 2.59.63	6.95	— 1.39
17.	+ 2.48.13	3.04	+ 0.25	7.	+ 2.54.38	5.25	— 0.84
22.	+ 2.49.36	1.13	+ 0.18	14.	+ 2.57.28	2.90	+ 0.41
24.	+ 2.48.11	1.25	— 0.62	21.	+ 3.03.27	5.99	+ 0.85
25.	+ 2.48.90	0.79	+ 0.79	26.	+ 3.08.69	5.42	+ 1.08
27.	+ 2.48.54	0.36	— 0.18	29.	+ 3.12.36	3.67	+ 1.22
28.	+ 2.49.67	1.13	+ 1.13	31.	+ 3.15.59	3.23	+ 1.61
30.	+ 2.53.22	3.55	+ 1.77	1821,			
July 3.	+ 2.57.70	4.48	+ 1.49	Jan. 13.	+ 3.36.19	20.60	+ 1.59
8.	+ 3.01.50	3.80	+ 0.76	17.	+ 3.37.72	1.53	+ 0.38
10.	+ 3.02.98	1.48	+ 0.74	22.	+ 3.73.73	2.01	— 0.40
11.	+ 3.03.61	0.63	+ 0.63	29.	+ 3.48.17	8.44	+ 1.21
16.	+ 3.04.18	0.57	+ 0.11	Feb. 1.	+ 3.50.40	2.23	+ 0.74
20.	+ 3.02.11	2.07	— 0.52	5.	+ 3.54.59	4.19	+ 1.05
21.	+ 3.00.60	1.51	— 1.51	7.	+ 3.37.96	3.37	+ 1.68
25.	+ 3.00.20	0.40	— 0.10	10.	+ 4.04.14	6.18	+ 2.06
27.	+ 3.00.64	0.44	+ 0.22	14.	+ 4.12.67	8.53	+ 2.13
29.	+ 3.00.84	0.20	+ 0.10	19.	+ 4.23.34	10.67	+ 2.13

Bushey Heath, Stanmore, 19*th Feb.* 1811.

Art. XXII.—*Account of the Establishment of a Scientific Prize by the late* Alexander Keith, Esq. of Dunottar. In a Letter from the Trustees to Sir Walter Scott, Bart. P. R. S. E.

In the month of January 1819, the late Mr Keith of Dunottar, intimated to me his resolution of leaving the sum of L. 1000 for promoting the interests of Science in Scotland, and at the same time requested me to take charge of this donation. In expressing my warm acquiescence in his views, I transmitted to him a general idea of the manner in which the legacy might be most advantageously applied; and I had afterwards various personal communications with him relative to this subject. Upon his death, which took place on the 26th February 1819, it was found that he had left the preceding sum, under the charge of his heir, the present Sir Alexander Keith, his nephew Mr James Keith, and myself.

The mode of appropriating the greater part of the legacy, will be seen from the following letter to Sir Walter Scott, Baronet, President of the Royal Society, and from the resolution of the President and Council annexed to it.

D. B.

"Gentlemen,

"It is no doubt already known to you, that the late Alexander Keith, Esq. of Dunottar, bequeathed the sum of L. 1000 for the purpose of promoting the interests of Science in Scotland. Having been appointed Trustees for the Management of this Fund, we have endeavoured to appropriate it in the most advantageous manner for the advancement of Science; and we have the satisfaction of stating, that the plan which has been adopted met with the special approbation of Mr Keith himself, to whom it was communicated previous to his death.

As the Royal Society of Edinburgh is the principal Scientific Establishment in Scotland, we hereby offer to its President and Council the sum of L. 600; the principal of which shall on no account be encroached upon, while the interest shall form a Biennial Prize, for the most important discoveries in Science, made in any part of the World, but communicated by their author to the Royal Society, and published for the first time in their Transactions.

With regard to the form in which this Prize is to be adjudged, we beg leave to suggest, that it may be given in a Gold Medal, not exceeding fifteen guineas in value, together with a sum of Money, or a Piece of Plate, bearing the devices and inscriptions upon the Medal.

If, during any of the biennial periods, commencing from Martinmas 1820, no discoveries of sufficient importance shall be communicated to the Society, the interest of the fund may be added to the principal, after paying the incidental expences incurred from the preparation of the dies and other causes.

Leaving all other arrangements to your judgment and discretion, we have only to express the hope, that this donation may realize the patriotic views of its Founder, and contribute in an eminent degree to advance the honour and interests of our native country. We have the honour to be, Gentlemen,

Your most obedient humble servants,

ALEX. KEITH.
J. KEITH.
DAVID BREWSTER.

EDINBURGH,
Dec. 4. 1820.

Resolution of the President and Council.

Resolved, That the President and Council of the Royal Society of Edinburgh, cannot forget the zeal with which their late venerable associate, Mr Keith of Dunottar, pursued every object that could forward the discovery and the dissemination of knowledge: and they receive the gift which has been announced by his Trustees, under the conditions prescribed, with sentiments of the most respectful remembrance and gratitude, and with the determination that the intentions of Mr KEITH shall be fulfilled, in a manner, it is hoped, which will do equal honour to his memory, and to the future successful candidates for the distinction of the Keith Medals.

Resolved further, That this resolution be transmitted by the President to the Trustees of Mr Keith, and that these Gentlemen be at the same time requested to accept the thanks of the President and Council, for the trouble they have so obligingly taken on the present occasion."

ROYAL SOCIETY HALL,
Dec. 18. 1820.

Art. XXIII.—*Description of a Magnetimeter, being a New Instrument for Measuring Magnetic Attractions, and Finding the Dip of the Needle; with an Account of Experiments made with it. By* William Scoresby, Esq. jun. F.R.S.E. M.W.S. &c.

In the month of December 1819, Mr Scoresby communicated to the Royal Society of Edinburgh, a description of a new instrument for ascertaining the Magnetic Dip. Having made very considerable improvements in the apparatus, by means of which some curious results on the magnetic laws, especially those that relate to the production and annihilation of magnetism in iron, have been obtained, he recently submitted to the Society a drawing and description of his improved instrument, together with an outline of some of the most interesting experiments made with it.

This instrument consists of a small table of brass, 4½ inches square, and 3¾ inches high, having a plate of brass attached to it by hinges, and moveable by means of a wheel and pinion, through an arch of 250° of a vertical circle. This plate has a small straight groove running from end to end, for the purpose of receiving bars of metal, the polarity of which is to be determined. These bars are readily fixed to the plate, by being slipped through a circular aperture in the end of a spring, which, perforating the moveable plate, and acting downward, firmly embraces any substance laid along the groove. The angular position of the moveable plate is marked by a graduated circle, screwed upon the side of the table. On the brass table is placed a moveable flat plate of brass, divided into rhumbs and degrees, and furnished with a magnetic needle, with an agate cap traversing on a brass or steel point. The needle can be changed according to the nature of the circumstances; a very light and strongly magnetized one being used in delicate experiments. The compass or plate carrying the needle, being moveable, its distance from the bar resting on the moveable plate, can be varied at pleasure. The centre of the hinges is one-tenth of an inch above the level of the table; the magnetized needle stands at the same elevation; and the bars in use being one-fourth of an inch in diameter, are sunk in the groove of the moveable plate to such a depth, that their axis, or centre, precisely corresponds with the centre of the hinges; hence the middle of the extremity of each bar is at the same elevation, and at the same distance from the needle in every position of the moveable limb. To give firmness to the instrument in making experiments, the table is fixed by the feet to a mass of lead, of seven or eight pounds weight. By means of this plate of lead, which has a screw at each corner, the whole apparatus is readily put into a horizontal position.

With this apparatus, Mr Scoresby made a series of experiments, which are fully detailed in the Transactions of the Royal Society of Edinburgh, Vol. IX., and of which the following are the principal results.

1. Iron bars become magnetical by position, excepting when placed in the plane of the magnetic equator; the upper end, as regards the position of the magnetic equator, becoming a south pole, and the lower extremity a north pole.

2. No attraction or repulsion appears between a magnetized needle and iron-bars; the latter being free from permanent magnetism, whenever the iron is in the plane of the magnetic equator; consequently by measuring the angle of no-attraction, in a bar placed north and south, we discover the magnetic dip.

3. Before a magnet can attract iron, that is totally free from both permanent magnetism and that of position, it infuses into the iron a magnetism of contrary polarity to that of the attracting pole.

4. A bar of soft iron, held in any position, except in the plane of the magnetic equator, may be rendered magnetical by a blow with a hammer, or other hard substance; in such cases, the magnetism of position seems to be fixed in it, so as to give it a permanent polarity.

5. An iron-bar, with permanent polarity, when placed anywhere in the plane of the magnetic equator, may be deprived of its magnetism by a blow.

6. Iron is rendered magnetical if scowered or filed, bent or twisted, when in the position of the magnetic axis, or near this position; the upper end becoming a south pole, and the lower end a north pole; but the magnetism is destroyed by the same

means, if the bar be held in the plane of the magnetic equator.

7. Iron heated to redness, and quenched in water, in a vertical position, becomes magnetic; the upper end gaining south polarity, and the lower end north.

8. Hot iron receives more magnetism of position than the same when cold.

9. A bar-magnet, if hammered when in a vertical position, or in the position of the magnetic axis, has it power increased, if the south pole be upward, and loses some of its magnetism if the north end be upward.

10. A bar of soft steel, without magnetic virtue, has its magnetism of position fixed in it, by hammering it when in a vertical position; and loses its magnetism by being struck when in the plane of the magnetic equator.

11. An electrical discharge, made to pass through a bar of iron, devoid of magnetism, when nearly in the position of the magnetic axis, renders the bar magnetic; the upper end becoming a south pole, and the lower end a north pole; but the discharge does not produce any polarity, if the iron be placed in the plane of the magnetic equator. The effects appear to be the same, whether the discharge be made on the lower or upper end of the bar, or whether it is passed longitudinally or transversely through the iron.

12. A bar of iron possessing some magnetism, has its polarity diminished, destroyed, or inverted, if an electric discharge be passed through it, when it is nearly in the position of the magnetic axis, provided the south pole of the bar be downward; while its magnetism is weakened or destroyed, if it receive the shock when in the plane of the magnetic equator.

13. Iron is rendered magnetical, if a stream of the electric fluid be passed through it, when it is in a position nearly corresponding with that of the magnetic axis; but no effect is produced, when the iron is in the plane of the magnetic equator.

Art. XXIV.—*Notice respecting Professor* Hansteen's *Chart of the Variation and Dip of the Needle.*

THE chart of the variation and dip of the magnetic needle which accompanies this Number, and which is marked Plate IV. was drawn by Professor Hansteen from the numerous tables of the declination and inclination of the needle which are given in his work on the Magnetism of the Earth, of which we have already presented an analysis to our readers. This chart occupies two separate plates in Hansteen's Magnetic Atlas; but we have thought it preferable to unite both in one, in order that the relation of the lines of Variation and Dip may be at once visible to the eye.

The *Lines of Equal Variation* are projected from observations reduced to the year 1787, whereas the *lines of equal dip* are projected from observations reduced to the year 1780.

In the original chart published by Hansteen, he makes the magnetic equator cut the terrestrial equator *only twice*, viz. in 108° of West, and 21° of East Longitude *; but in his letter to our correspondent M. Rumker, of which we have already availed ourselves in this Number, he states, that his own chart is in this respect erroneous, and *that the Magnetic Equator actually crosses the terrestrial equator* FOUR *times*, viz. in 25° of East, and 108°, 125°, and 170° of West Longitude,—a correction which we have carefully made in the accompanying chart, altering, at the same time, the adjacent lines of 10°, 20° and 30° of North and South Dip, which must necessarily follow the inflexions of the Magnetic Equator.

The *Western Line of No Variation*, which is more strongly marked than the rest, and passes along the Atlantic, and to the west of Hudson's Bay, corresponds, very nearly, with the same line on the chart after Churchman, which we have already men-

* In the chart of the variation and dip, principally from Churchman, and reduced to 1794, published by Dr Thomas Young, and forming Plate 43d of his *Elements of Natural Philosophy*, vol. i. the Magnetic Equator cuts the real Equator only twice, in 170° of West and 15° of East Longitude.

tioned; but the *Eastern line* differs in a very remarkable manner from the same line in Churchman.

In Hansteen's chart, the *Eastern line of no variation* passes through New Holland to Archangel, after making numerous inflexions among the Indian Islands, and through the continent of Asia; while Churchman gives it nearly a rectilineal course from New Holland to a little beyond Enisesk in Siberia, where he makes it terminate. In the chart of Hansteen, the lines of eastern variation from 0° to 10°, partake of course of the sinuosities of the line of no variation; but though they resume a more uniform course to the west, yet in the Pacific Ocean they form a series of returning curves of the shape of a heart, which have no resemblance to those in Churchman's chart.

In examining the different groups of the *Variation Lines*, the reader will observe that they are represented on the engraving by *three* different kinds of lines. The lines marked thus, ———— continuously black, are the lines which are best determined. Those marked thus, —..——..——..— have an inferior degree of evidence; while those marked by a single dotted line thus, ... are merely interpolated by estimation. The same remarks apply to the *Lines of Dip*, where, however, only the continuous and the dotted lines are used. The *Lines of* 65° and 75° of *North Dip*, for example, are entirely interpolated; and also the Asiatic portion of the lines of 60° and 70° of North Dip, and the Atlantic portion of 60° of South Dip.

In the present chart, we have added the new discoveries of Captain Parry, and New Shetland; and also one or two points of variation in Baffin's Bay, together with the *Poles of maximum Cold*, which we have recently deduced from a comparison of meteorological observations *.

D. B.

EDINBURGH, *March* 1. 1821.

* See *Transactions of the Royal Society of Edinburgh*, vol. ix. p. 214.; and the present volume of this *Journal*. p. 193, 194.

Art. XXV.—*Account of a Remarkable Shower of Hail which fell in Orkney on the 24th of July* 1818. By Patrick Neill, F. R. S. Edin. F. L. S. & Sec. Wern. Soc. *

The morning of the 24th of July 1818, was, in Orkney, clear and warm, with a slight air of wind at due south. About midday the atmosphere became overclouded. Between twelve and one o'clock, thunder and lightning began; and after these had continued with little intermission for about an hour and a half, the Reverend Mr Taylor of Stronsa observed a very dense jet black cloud, apparently rising from the sea, at the distance of about five or six miles. It then seemed of no great dimensions; but its magnitude was gradually developed, as it approached steadily, and apparently with increasing velocity, from the southward, in a direct line toward the centre of the island. It now assumed a dismally ominous aspect, and occasioned a considerable degree of darkness. The lightning became proportionally more vivid, and the peals of thunder more tremendous. Mr Taylor remarked one flash of lightning to be not only brighter than the rest, but to exert a more extensive influence on the cloud, which seemed as if cleft asunder, and presented a momentary opening of the prospect between the Mainland of Orkney and the Island of Stronsa. The thunder-bolt on this occasion seemed to strike the surface of Stronsa Frith in the manner of a solid body dashing into the sea.

Richard Caithness, who possesses the farm of Hunday in the island of Stronsa, was engaged in the making of kelp on the shore, when he perceived the cloud advancing fast towards his own farm-steading. He immediately hurried home. At this time the wind began to rise; the surface of the sea was greatly ruffled; and darkness like that of night threatened to come on. Just as he reached his house, the cloud overtook him. The lightning was now instantaneously followed by

* Abridged from the *Transactions of the Royal Society of Edinburgh*, vol. ix. p 187., to which the reader is referred for a fuller account of this very remarkable phenomenon. Mr Neill's paper is illustrated with a map shewing the track of the hail shower.

noises, like the firing off of " guns in Stronsa Caves." Hailstones of very uncommon magnitude began to fall. The first large hailstone which Mr Caithness saw, came through the glass of one of his windows, and struck the floor violently: it was, to use his own phrase, " really like a goose-egg." In two or three minutes more, the wind increased almost to a hurricane; and instead of hailstones of the usual shape, " pieces of ice," of almost all forms, were precipitated with the utmost violence. Not only was every pane of glass in the windows of the house, fronting the south, speedily broken, but the cabbage-plants in the garden, which were of the largest and strongest kind, seemed as if suddenly cut over, and strewed about the ground. The " clattering noise" of the hail which fell in the sea at this time, is described by Mr Caithness as quite terrific; and, having looked to the sea, he adds, that not only did the hail keep the water as it were boiling, and covered with white foam, but he repeatedly saw the lightning striking from the cloud into the sea, and the water, where it was struck, " dashing up as high as masts of ships." The lightning was not forked or ziz-zag, but rather in the form of balls or masses of fire *.

The farmer and his family had not recovered from the consternation excited by such an extraordinary event, when the wind and hail ceased, and the sky began to clear. When they ventured to look abroad, the fields presented a scene of perfect desolation. In the " close" or farm-court, surrounded by offices, the hailstones had accumulated, and lay a foot and a half deep! In the open fields, although they did not perhaps exceed the half of this depth, yet not only were the crops of every kind utterly beaten down, but not a vestige of them was for some time to be seen. The astounded farmer saw only " fields of rough ice." All this destructive change had been accomplished in less than ten minutes.

Alarmed by the horrid cries, very different from the usual bellowing, of some black cattle, which had been grazing on pasture-land at some distance, Caithness attempted to wade out

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* It is remarkable that this happened at no great distance from the spot where a shower of meteoric stones fell in the end of the seventeenth century, one of which, as recorded by Wallace, penetrated a fishing-boat. See this Journal, vol. i. p. 228.—Ed.

among the hailstones in the direction of the cattle. The "loose ice," he says, slipped below his feet, and sometimes, when he happened to stumble, reached to his knees. In this way his legs were so much cut by its sharp edges, that he was soon obliged to desist, and to wait till the ground began to appear, by the melting of the hail. The pieces of ice he describes as of various shapes: most of them were round like eggs; many were flattened, and not unlike "thick clumsy oyster-shells;" some were smooth on the surface, others ragged and jaggy. Some of these appearances probably arose from the hailstones being partly dissolved, the weather being warm. Mr Taylor likewise remarks, that some "were as finely polished as marbles, while others were irregular, and apparently made up of pieces of conglomerated ice;" and that the largest lumps he observed were about six inches in circumference. Mr Caithness thinks, that the largest piece of ice which he lifted, might weigh from four ounces to nearly half a pound; and he describes the hailstones as being generally of a greyish-white colour, not unlike fragments of light-coloured marble.

The terrified black cattle and horses, which had broken their tethers, and been observed, at the beginning of the fall of hail, running violently backward and forward, galloping and flinging, had now collected together in a herd. Caithness at length made his way to them through the half-melted ice: they still trembled exceedingly; some of the horses had lain flat down on the grass, with their heads stretched out; and all of the animals were more or less cut, and bleeding. Some of the weaker horses, the farmer says, will never recover: the milch cows, he adds, were struck *yeld*, or gave no more milk, and indeed would not suffer the people to attempt to milk them any more.

On the links or downs, at some distance from Caithness's house, a large flock of tame geese had been feeding: these, he remarked, seemed to remain motionless on the turf; and on proceeding to the place, he found many of them wholly deprived of life; a few were still living, but so much injured, that all of them pined away and died in a short time. Some of these poor birds had their bills split; others had an eye struck from its socket, and hanging by the nerve; and the brains of some were fairly knocked out: many had either a leg or a wing broken.

Owing to the heat of the season, the ice soon disappeared; and Caithness's fields, which, less than an hour before, had been covered with corn-crops just beginning to come into ear, and superior in luxuriance to what had been seen in Orkney for many years, seemed (to use the farmer's expression) to have been "absolutely plowed black."

Many of the hailstones which fell first were sunk in the corn-fields from three to four inches deep; and even in the firm old pastures, each of them had made a hole in the sward exactly of its own size and shape, to the depth generally of about two inches. In some of these holes the balls of ice lay unmelted, long after the others had disappeared. Mr Taylor says, that the surface of the ground all around his house was every where perforated as with the "broad point of a country man's staff;" and it retained this appearance for several days.

The hailstones, too, had, from the strength of the wind, fallen at a very considerable angle. Mr Taylor was obliged to run from one room to another in his house, in order to avoid the fragments of glass, which were driven to the farther side of the apartment; and in his bed-room, the wash-hand bason, although standing at some distance from the window, was shivered in pieces by a hailstone.

As the ice melted away, great numbers of small birds, particularly skylarks, starlings, corn-buntings, and *chacks* or wheat-ears, were found dead, and were collected in heaps by the boys belonging to Caithness's farm. On the shore, near to a point called Torness, were observed numbers of rock-pigeons, hooded crows, *tysties* or guillemots, and ducks, which had been killed at sea by the hail, and were left by the receding tide. Many wounded gulls and *picktarneys* or sea-swallows, were seen floating on the sea, occasionally attempting to fly, but unable to raise themselves.

Owing to the thunder and lightning having for some time preceded the great fall of hail, the people at work in the track of the cloud had all taken shelter. One boy alone, named Peter Stevenson, suffered from exposure: he ran towards a projecting crag at the sea-beach for protection; but before he could reach it, he received a severe blow on the back of the neck, which stupified him, and produced a contusion, from the effects of which he had not recovered after the lapse of some months. Four men in a boat, at some distance from land, were exposed to a part of the shower, and had their hands much cut and bruised by the hailstones.

It does not appear that the electric fluid had any share in killing the geese or other birds, at least no marks of discoloration were observable, and the palpable blows which they received were sufficient to account for their death. The cows being "struck *yeld*," as Caithness expresses it, seems a curious circumstance; it is ascribed by him to the dreadful fright they got. The wounds received by the cattle and horses were all evidently inflicted by the hailstones. It is proper to add, however, that, in some places, Caithness observed the surface of the pasture-grass to be much discoloured and scorched-like; and a good deal of the broken straw of the grain-crops likewise "coloured white by the fire, as if it had been suddenly ripened." Mr Taylor informs me, that when he first went abroad, immediately after the cloud had passed over, he was not only sensible of a sulphureous smell, but that it was so strong that he had speedily to return for a draught of water, in order to remove the disagreeable sensation in the throat. He observed that the cattle afterwards avoided certain scorched parts of the pasture, which did not recover their verdure till repeated showers had refreshed them.

Richard Caithness was not the only farmer whose crop and farm-stocking were injured. George Foulis, tenant of the farm of Holland, a possession of much greater extent and value, was equally involved in the devastation. This farm, lying to the southward of Hunday, was of course to the windward; and Mr Caithness told me, that the "dismal yells" of Foulis's wounded cattle, on the high grounds between the two farms, and which reached him, notwithstanding the noise of the hail, produced a feeling of horror which he could not describe,—but that the cries seemed still to sound in his ears. The farm of Airie was likewise greatly damaged.

The meeting-house and manse of the Reverend Mr Taylor were in the line of the cloud. In both, the south windows were wholly shattered, not only the glass, but the wooden astragals being broken. Mr Taylor observed by his watch the duration of the violent wind and heavy hail, and states it to have been little more than eight minutes.

The thick layer of ice or hail formed a tolerably well-defined belt across the island, in a direction from S. SW. to N. NE. This belt might be about a Scots mile broad,—perhaps nearly 1½ English; and beyond this line, on each side, the ground appeared "spotted with ice." In proof of the extremely local nature of the shower, it may be mentioned, that persons who had been employed the whole day in digging turf near Rothiesholm Head, at the distance of little more than two miles in a direct line westward from Caithness's house, were wholly exempted from its influence. They had observed a very thick black cloud shooting past the high rocks of the headland in the afternoon; they had seen bright lightning, and heard loud thunder; but they had not been touched by the hail. The same thing happened to the eastward; the farm of Cleat, situated only about 1½ mile distant in that direction, having scarcely been affected by the shower. But even to the southward, (the direction from which the cloud came), the range of the storm was very limited. The peninsula of Deerness, belonging to the Mainland of Orkney, was directly in the line, about seven or eight miles to the S. SW.; yet it remained untouched. Mr Caithness indeed mentions, that he had spoken to some "Deerness men," who were that day fishing off the Moul Head, and who told him that they observed the cloud thickening and blackening as it rolled on towards Stronsa.

It would appear, therefore, that the accumulation of electric matter came to a crisis over the sea, at the distance of about three or four miles only to the SW. of Stronsa. The cloud swept up Rothiesholm Bay, and crossed the island in the way already described. When nearly in an exhausted state, it touched the north-east corner of the island of Sanda. Although the main force of the shower was now spent, the effects were still formidable; a good deal of the glass in the windows of Mr Strang's house at Lopness having been shattered. As the cloud was passing off, the barometer at Lopness House was observed to indicate 27.76. The mercurial column had sunk two inches; for in the register kept at the Start Point Light-house, about a mile from Lopness, the marking at 8 A. M. was 29.68. When the cloud had completely passed, Mr Lindsay, student of Divinity, having gone into the garden at Lopness, observed that the "cabbages were perforated as if musket-bullets had been shot against them."—"About an hour afterwards," he adds, "I picked up some that still remained undissolved, and found that they measured $1\frac{3}{20}$th inch in diameter. They were for the most part of a spheroidal form, consisting of a nucleus resembling common hail, occupying about $\frac{1}{3}$d of the diameter, encrusted by a coating of transparent ice. Some of the stones, however, were irregularly formed into a sort of crystallized mass."

ART. XXVI.—*Abstract of Mr* HERSCHEL'S *Experiments on Circular Polarisation* *.

IN the 3d volume of this Journal, p. 397. we have already given a brief abstract of the important results contained in Mr Herschel's paper on circular polarisation; and our readers will find in Vol. II. p. 179, 180. a short notice of what had been previously done on the same subject †.

Mr Herschel's memoir is limited to an examination of the properties of that variety of quartz to which Haüy has given the name of *plagiedre*. One of these crystals is represented in Plate VII. Fig. 7., where the faces x, x, x, and x', x', x', peculiar to this variety, lean, as it were, in one uniform direction round the summit A, which is adjacent to them, the angle formed by these faces, and the adjacent sides of the prism, being greater on one side (the right, for instance,) than it is on the other. If the summit a is placed uppermost, by inverting the crystal, the plagiedral faces adjacent to this summit obey the same law, and turn in the same direction.

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* This ingenious paper, read April 17. 1820, will immediately appear in the Transactions of the Cambridge Philosophical Society, vol. i.

† See also p. 421. of this Number.

"The faces in question," says Mr Herschel, "originate in those laws of decrement which Haüy has called intermediate. The primitive form of quartz is a rhomboid, slightly obtuse, whose axis is parallel to that of the hexagonal prism. The subtractive molecule by which the decrement on the angles E (Fig. 8.) takes place, to produce the faces x, is composed of eight of these rhomboids, its edges consisting respectively of one, two and four edges of the primitive rhomboid; and the decrement resulting is represented in Haüy's notation by $(E^{4}_{x} D^{2} D^{1})$. The alternate faces x' arise from a different law, (as they obviously must, the angles upon which they are produced being differently related to the superior vertex). Their law of decrement cannot be reduced to an integer expression, but is represented by $(\frac{4}{5}\, E^{4}_{x} D^{2} B^{1})$, in the same notation *."

Upon cutting plates perpendicular to the axis of this interesting variety of rock-crystal, Mr Herschel found that the direction of the polarisation *was constantly the same as the direction of the plagiedral* PLANES, the polarisation being *direct* or *retrograde*, according as these faces leaned forward or backward round the summit. The number of crystals which he examined amounted to no fewer than *twenty-three*, and in all these, *without a single exception*, the direction of the polarisation was the same as the direction of the faces, "although M. Biot," as Mr Herschel remarks, "has assured us that no peculiarity in the crystalline form can lead us to conjecture what may prove the direction of rotation in a given specimen of rock-crystal previous to trial."

Notwithstanding the generality of the fact discovered by Mr Herschel, he observed in the possession of Mr Brooke a crystal of quartz, which exhibited on one and the same angle of the prism plagiedral faces perfectly distinct and in contact, but leaning opposite ways round the summit. We trust that Mr Brooke will sacrifice this specimen, or rather a part of it, to the good of science, and enable Mr Herschel either to establish or overturn the important relation which he has discovered. We venture to say, with confidence, that this crystal is a

* See Haüy's *Traité de Mineralogie*, 4to, Plate 45. and tom. ii. p. 297.

colourless amethyst, of which we are in possession of several specimens.

Another experiment of Mr Herschel is, in our opinion, equally hostile to M. Biot's notion, that circular polarisation is an inherent property of the ultimate particles of matter *. He prepared the *Liquor Silicum*, (a solution of silica in potash), from a portion of a plagiedral crystal, which turned the plane of polarisation to the left; but *it possessed no circular polarisation.*

Arguments of a similar kind had been urged by Dr Brewster against the opinion of the French philosopher. When he discovered more than five years ago the double system of rings in crystallized sugar, he observed that there was no circular polarisation at the two poles, although solutions of sugar were known to possess that property; and in his paper on the Amethyst, he states, that neither *Opal* nor *Tabasheer* (which is nothing more than the *Liquor silicum* solidified,) have the rotatory property of quartz. Another argument still more convincing will be found in our Scientific Intelligence, from which it appears, that Dr Brewster has examined a piece of *Melted Quartz*, which had been entirely deprived of its ordinary polarising structure, and has found that *it exhibits no traces of circular polarisation.* Each of these facts we regard as an *experimentum crucis* sufficient to decide the question; and we have brought them forward at present, because Mr Herschel seems to think it possible that the rotatory property may be inseparable from the ultimate particles of the body which exhibits it.

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* Faculté qu'elles ne peuvent perdre que lorsqu' elles *cessent d'etre elles-memes*, par leur decomposition.—*Mem. Inst.* 1818.

Art. XXVII.—*Observations on the Nature of Flame, drawn from several Experiments performed with an Apparatus for Discharging Ordnance without the use of a Match or Prime-Tube.* *By* John Deuchar, M. W. S., and Lecturer on Chemistry in Edinburgh. Communicated by the Author *.

THE apparatus with which the following experiments were performed, was suggested by Lieut.-Col. Udney Yule, for discharging ordnance upon Mr Forsyth's plan, and will be understood from Plate IX., and the explanation of it given at the end of this paper. In all these experiments, the new fulminating powder used, was exploded by a stroke from a wooden hammer weighing nearly 1 lb. The stroke was applied to that part marked C of Fig. I. and CD was brought down previous to the discharge, so as to rest upon I. The end F was rested upon a table, and the other end E was held in the hand.

I. I first directed my attention to such experiments as I thought most satisfactory in proving the application of the apparatus to the firing of ordnance of every description; and for this purpose the first seven experiments have been selected.

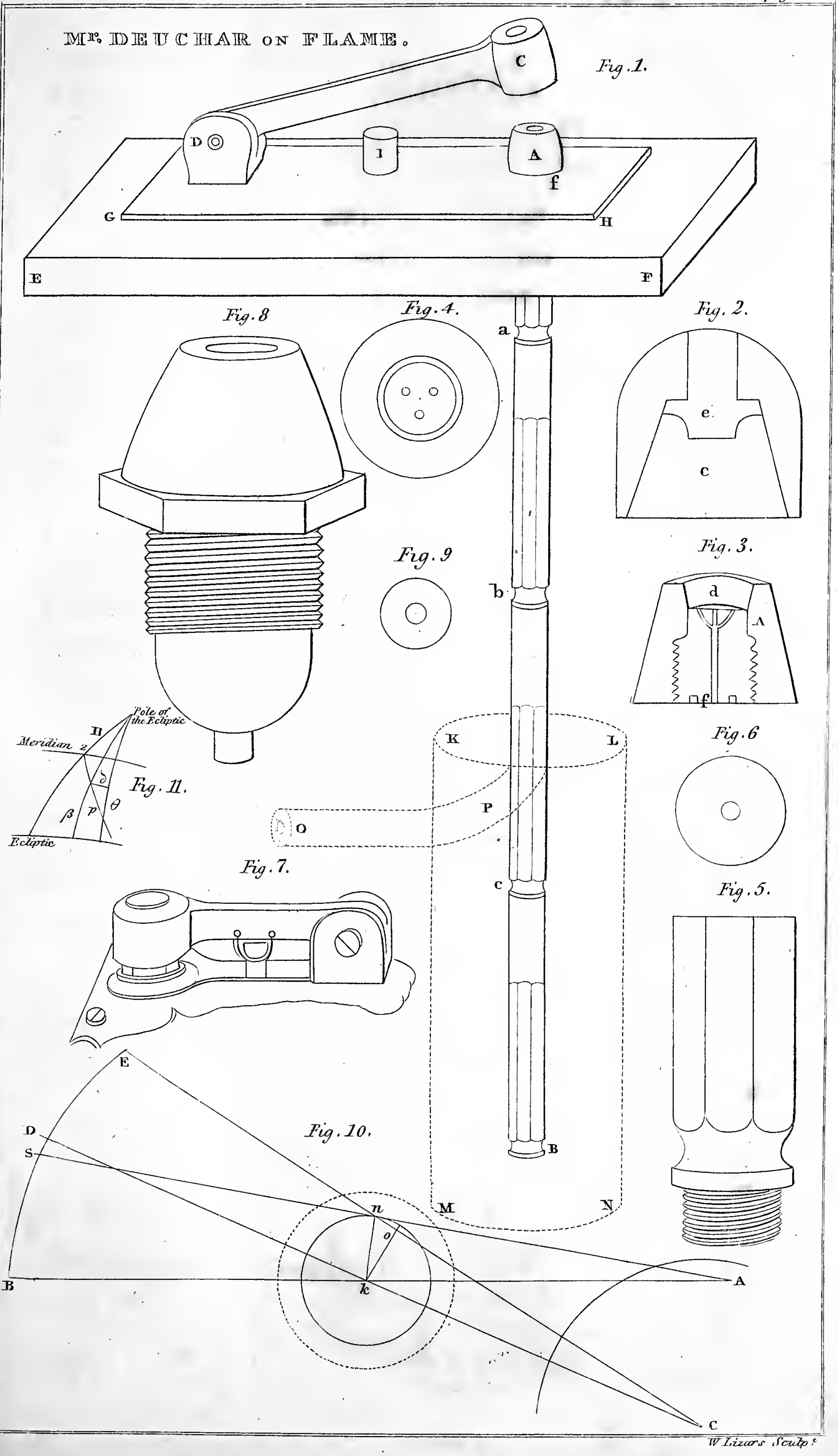
Exp. 1.—A piece of flannel was put over the bottom of a tube 15 inches long (See Pl. IX. Fig. 1. B.), and immediately below, and close to it, was tied two folds of paper, with a quantity of gunpowder. Upon exploding a grain of the new fulminating powder at the top (A), the flame was forced down the whole tube, and the gunpowder was fired. When the gunpowder is wrapped in a single piece of thin paper, it often happens that the flame forces through without firing it. When this takes place, the whole or a part of the gunpowder is scattered about, and the paper is rent asunder, without any appearance of combustion.

Exp. 2.—The first experiment was repeated, the gunpowder being surrounded by flannel. Upon exploding the fulminating powder at the top, the flame pierced the flannel, and inflamed the gunpowder.

Both these experiments prove, that the flame of the new fulminating powder can descend through a tube 15 inches deep,

* This communication is drawn up from three papers on the subject read before the Wernerian Natural History Society, and published in their Memoirs, vol. iii.

Edin.r Phil. Jour. Vol. IV. page 374.



W. Lizars Sculp.t

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pierce a piece of flannel, and fire gunpowder. And supposing the tube to represent the touch-hole of a gun, and the flannel and gunpowder to be a substitute for the cartridge, then we may conclude that the gun would be discharged, although the cartridge were 15 inches distant from the fulminating powder, which never occurs, even in the largest pieces of ordnance. An objection, however, arises as to the above conclusion; that it may be owing to the tying being very close, and the flame having no room to spread, that the gunpowder was inflamed in the 1st and 2d experiments, and that when applied to the gun the flame may be lost over the surface of the cartridge. To answer this objection, the two following experiments were performed.

Exp. 3.—A quantity of gunpowder was scattered over the bottom of a circular tin canister, (See Pl. IX. Fig. 1. KLMN.) 8 inches deep, and nearly 3 in diameter. Over the powder was laid a piece of cartridge flannel. The tube (AB) was made to descend into the canister, to within 2 inches of the flannel; and then a grain of the fulminating powder was exploded at the top. The result was quite satisfactory, the flame pierced the loose flannel, and fired the gunpowder.

Exp. 4.—A tube 14 inches long, was bent at the 10th inch from the top, so as to present 4 inches out of the straight line in which the flame formerly proceeded, and through which it must now pass before it could issue from the under end, (See Plate IX. Fig. 1. OP.) Upon exploding the powder as before, the flame issued from the bent end of the tube.

Exp. 5.—In order to ascertain whether the apparatus were apt to clog up, or miss firing from repeated use, it was discharged 130 successive times, and never failed to produce the proper effect; and still the apparatus did not require to be cleaned for future use.

Exp. 6.—In order to determine the temperature at which the new fulminating powder would spontaneously explode, a number of experiments were made. In one of these there were placed upon a circular tin plate, at three situations, with 2 inches intervening, forming, as it were, the points of an equilateral triangle, sulphur, gunpowder, and the fulminating mixture, one grain of each; below the centre of this triangle, was put a taper, the flame of which was so near as to spread a little upon the tin-plate. In one minute the sulphur began to melt, and in 25 seconds more it was all melted; at the end of 10 minutes, neither of the powders appeared to be altered, but nearly one-half of the sulphur was converted into vapour; at this time the plate was too hot to be touched by the hand.

Exp. 7.—A grain of the fulminating powder, and the same quantity of gunpowder, were put upon a tin-plate, at 2 inches distance; and at the centre below was put a spirit-lamp. The following is the result of the time of explosion in several trials:

Fulm. Powder.	*Gunpowder.*	*Fulm. Powder.*	*Gunpowder.*
In 32 seconds.	In 46 seconds.	In 45 seconds.	In 85 seconds.
28 ——	44 ——	30 ——	60 ——
25 ——	60 ——	40 ——	60 ——
29 ——	62 ——	41 ——	60 ——
40 ——	70 ——	60 ——	92 ——

In obtaining these results, the distance at which the spirit-lamp was put below the tin-plate sometimes varied considerably, but it was always near enough to spread a little upon its surface. This, however, so far accounts for the great difference between the periods of explosion in the same powder.

Should the firing succeed as regularly when applied to the gun itself, there could remain no doubt but that it would possess all the proposed advantages. There was, therefore, fixed to a six pounder an apparatus similar to the one used for trying the experiments narrated in this paper, excepting that it wanted the long tube AB, for which the priming hole of the gun became a substitute, (See Figs. 7. and 8.) It was charged with cartridge, and, in several of the trials, with ball and cartridge; and upon the same experiments being repeated with it, it gave the same uniform results.

At the request of Colonel Yule, I commenced, about the beginning of July last, a number of experiments, with the view of discovering a powder which should never miss inflaming the cartridge. The fulminating mercury, when the fifth part of a grain only was used, rent asunder the steel-plate at the top (D), and yet did not reach as far as the gunpowder at (B). Some of the antimonial preparations were found sometimes to fire the gunpowder; but they left a cake of crocus behind, which stopped up the holes, and could not easily be removed.

Indeed, all the usual fulminating powders were tried without success; but I was fortunate enough at last to hit upon one which has never failed to produce the desired effect.

For the composition of the different powders, and the advantages of this mode of firing ordnance, the reader is referred to the third volume of the Wernerian Society Transactions, just published.

II. Having established as far as was at present necessary Col. Yule's proposed application of the apparatus, I next directed my attention to the effect that might be produced by retarding the motion of the flame. This was, therefore, tried in various ways which had not yet been noticed.

Exp. 8.—A piece of cartridge flannel was tied over the under part (B) of the tube, and about one grain of the new powder was exploded at the top (A). The flame was seen to dart from the bottom. The flannel, when examined after the discharge, had not the slightest appearance of having been scorched; but it was, however, blackened a little at the spot through which the flame had passed.

Exp. 9.—The 8th experiment was repeated with several pieces of flannel at once. After each discharge with two pieces, the interior one was a little scorched, but the exterior one appeared as formerly. When three pieces of the flannel were used, the flame seemed with difficulty to pierce them; that in the interior was more scorched than when there were two pieces only, and part of it was entirely gone; the middle flannel was also slightly scorched. When four pieces of flannel were applied, the interior two were much burnt, and the third a little; but the flame did not pierce through the fourth piece. When this last was several times repeated in a very dark situation, there could not be discovered the slightest appearance of the flame at the bottom of the tube.

Exp. 10.—When two pieces of thin coarse paper were put at the bottom of the tube (B), the flame passed through, making a rent in the paper, without burning it in the least. When the paper was examined, it presented, on each side of the hole, the separated threads, as if it had been torn with the hand. With four pieces of paper the flame did not pass through. When paper and flannel were used at the same time, it was found that the interior one was always a little scorched.

From several of these results it would appear, that when the flame proceeds with great velocity, its power of acting upon inflammable or other substances is so far prevented; but whenever we, by any means, retard that motion, we facilitate its action. In the 8th experiment, when one piece only of flannel was used, the flame passed through without scorching it; but it was found in the 9th experiment, that as the resistance was increased by additional pieces of flannel, the more of the scorched effect was observed. The same was illustrated in the 10th experiment, when a piece of paper was put below one piece of flannel, and when the flannel was put below the paper.

III. Independent of the proposed application of the apparatus, it appeared of considerable importance to ascertain how far the flame might be thus propelled, and the greatest distance at which it could explode the gunpowder.

Exp. 11.—To determine the distance to which the unretarded flame could be forced by the explosion, there was fixed to the apparatus a tube 26 inches long. After numerous trials with this, and with tubes of decreasing lengths, it was found that no flame appeared at the bottom, till the tube was shortened to $23\frac{1}{2}$ inches, and then it was very feeble, and of a pale blue colour.

Exp. 12.—The next circumstance for inquiry was the distance at which the flame could explode the gunpowder. When the gunpowder was put immediately in contact with the lower aperture of a tube $23\frac{1}{2}$ inches long, it was fired; but when a piece of flannel intervened it was not acted upon. Thus it appeared, that although the flame, at $23\frac{1}{2}$ inches distance from the source of its production, could inflame a quantity of powder, yet it had not force enough to pierce even one piece of flannel. The tube was now gradually shortened, and trials made at each change, till it was reduced to between 19 and 20 inches, when it fired the gunpowder through the flannel.

IV. The next experiments were with the view of ascertaining how the results, obtained with this apparatus, might stand related to Sir Humphry Davy's theory regarding the impervious nature of wire gauze to flame.

The five following experiments are meant to illustrate this part of the investigation. These notices have been confined to two kinds of gauze; the one considerably coarser than the other. A square inch of the coarser gauze contained 1296 meshes, being 36 wires in the length; and the same quantity of the finer gauze contained 4900 meshes in the square, being 70 wires in the length. Now, upon examining two of Sir Humphry Davy's lamps, one for magnetic purposes with copper gauze, and another for common work with iron gauze, it was found that an inch of the gauze of the former contained only 26 meshes in the length, and 676 in the square; and that the gauze of the latter contained 28 meshes in the length, and 784 in the square; shewing, that even the coarsest wire-cloth which has been used, is finer than what is employed in the safety lamp; and that these results acquire additional strength in proving, that the wire-gauze is not impervious to the flame extricated by the explosion of the fulminating powder.

Exp. 13.—A tube, which could be separated into six pieces of nearly the same length, was screwed to the apparatus, making the distance from the top (A) to the bottom, fully 23 inches. A piece of the coarser wire-gauze already described, was put upon the hole at the joining *a*, when the fulminating powder was exploded at A, the flame passed through the gauze, and appeared at the bottom of the tube. The same kind of wire-gauze was next placed at *a* and *b*, and then at *a*, *b* and *c*, at the same time; and the flame passed through all the pieces. This effect was also obtained, when similar pieces of wire-gauze were put at all the five joinings of the tube at once. In this last result, the first piece of wire-gauze was $4\frac{1}{2}$ inches from the top (A); the second $8\frac{1}{4}$; the third 12; the fourth 16; and the fifth 20; and the flame appeared at the bottom, after a passage of $23\frac{1}{2}$ inches through five pieces of the wire-cloth.

Exp. 14.—As the flame could not pass through the whole of the tube, when the joinings were increased beyond $23\frac{1}{2}$ inches, it was impossible to try an additional number of pieces of wire-gauze, by adding them in the same way. This was therefore accomplished by putting more than one at the same joining. I next found, upon repeated trials in this way, using the tube 15 inches long, as shewn on Plate IX. Fig. 1. that the flame could pass through 3, 6, 9 and 12 pieces at once; these being placed 1, 2, 3 and 4 pieces at each of the joinings *a*, *b*, and *c*.

Exp. 15.—Although, by the two last experiments, it was proved that the flame could pass through the coarser wire-gauze when increased even to 12 pieces, yet it did not follow that it was not thereby altered somewhat in its nature. A probable change was, that it might become inert with regard to inflammables, as takes place in the several safety lamps, and particularly that of Sir Humphry Davy. Several experiments were tried, to ascertain if this suggestion were correct; first, the wire-gauze was put at *a*; then at *a* and *b*; and lastly, at *a*, *b* and *c*; placing at the same time, during each trial, a quantity of gunpowder in a piece of flannel at the bottom of the tube; and in all of these it was found that the gunpowder was inflamed, and the wire-gauze not in the least injured.

Exp. 16.—The result was next tried, firing the fulminating powder, whilst the finest wire-gauze was placed first at *a*, then at *a* and *b*, and then at *a*, *b* and *c*, and it was found that the flame still appeared at the bottom; shewing that the gauze, although much finer than that used in Sir Humphry Davy's safety lamp, was not impervious to this flame. In some of the experiments a hole was found to have been made in the centre of the wire-gauze, and sometimes the parallel wires were forced wider. This was very often the case, when a piece of wire-gauze was put at all the joinings, *a*, *b* and *c*, and then it was the gauze at *a* which was torn, or otherwise injured.

Exp. 17.—In order to ascertain if the flame still remained unaltered, notwithstanding its having passed through the finest gauze, a quantity of gunpowder in flannel was affixed to the bottom of the apparatus, and it was inflamed through one, two, and even three pieces of the gauze. Here the same occasional appearance, noticed in the last experiment, occurred, with regard to the upper piece of wire-gauze.

V. Before the discovery of the powder which has been since used, a mixture of equal parts of the impure antimony of commerce and super-oxymuriate of potassa was employed, which was irregular in its effect, and formed a cake of *crocus* at the top. In firing this mixture, however, it occasionally happened, that the flame passed through at B, without inflaming the gunpowder; this at first was supposed to be owing to the bursting of the paper containing the powder, but I afterwards began to suspect, that it might proceed from some peculiar character of the flame. Probably it might require more air than was present, to enable it to display its full energy. Under these circumstances, gunpowder placed in the joinings of the tube, would not be acted upon by the flame passing through it; and this is so far verified by the following experiment.

Exp. 18.—At the bottom of one of the divisions (*a*, *b* or *c*) of the tube, was put a small piece of flannel, so as to cover the hole there; and upon this were poured two, three, or four, and in some trials even five grains of gunpowder. Upon exploding the fulminating powder at A, it was found in some of the experiments, that the flame had passed through the gunpowder without firing it; but at other times this did not take place. In a few experiments, gunpowder was put at two of the divisions (*a*, and *b*), when it was found that the flame sometimes went through both, without firing either of them; at other times one portion was inflamed, and one left unaltered. The result, however, is by no means regular in its occurrence; sometimes I found it to succeed in three successive trials; at other times I failed four or five times before obtaining this curious effect. In all these cases, the powder was made to cover the whole surface of the piece of flannel upon which it was poured. This variety of effect seems to take place from some accidental circumstances, which have as yet escaped my notice. At some times I have succeeded best when gunpowder was used, the grains of which were large, and at other times, again, the small-grained gunpowder was most uniform.

This, at first, appeared to be an objection to the proposed application of the apparatus. But after many trials, it was found that the above curious result only took place when the stroke with the hammer was slight; for when a smart blow was given, inflammation always took place.

The principal cause we may adduce for the powder remaining uninflamed, under the above circumstances, is the rapid motion of the flame. We are entitled to draw this conclusion from the phenomena which occurred in the 1st, 8th, and 10th experiments; in these we found that the flame did not act upon the substances through which it passed when the resistance was feeble. But in the 9th and 10th experiments, when the resistance to which it was opposed was increased, then its effect upon the substances was more apparent. The same change of effect seems also to take place with regard to the gunpowder; when the resistance is increased, the powder is always inflamed, and the apparent inertness only takes place when the motion of the flame is left almost wholly free. The failure of effect alluded to in several of the trials in the 24th experiment, may have occurred from the flannel having been too thick and compact, or from too large a body of flame having passed down the tube at one discharge.

Another cause may be assigned for the gunpowder remaining uninflamed. There is scarcely any air contained in the spaces *a*, *b* and *c*; the flannel and gunpowder nearly fill the whole, so far as the tube is unscrewed, and the tube itself contains little air. Now, a certain quantity of air may be necessary to enable the caloric, in the insulated and condensed form in which we may assume it to exist during this rapid motion, to display fully its usual effects upon substances. When this supply of air is not present, then the caloric passes through the gunpowder and other substances without inflaming, or otherwise affecting them; but when we put resistance at the bottom B, we facilitate the concentration of the air contained in the tube, and therefore promote the action; or when we leave a quantity of air at *a*, *b*, or *c*, we in like manner assist the inflammation.

The above explanation will appear in a still clearer point of view, when we consider the nature of those affinities which often take place between bodies, when in a nascent state, although every attempt has failed to unite them, after they have assumed their separate forms. The same may occur with regard to flame. When propelled in an insulated form, it may not act upon inflammables placed at a distance from the point of its disengagement; but, when it meets with resistance, in contact with such substances, or when it is presented to them in its nascent state, then its full energy may be displayed. Its effects, therefore, would be more strikingly displayed, were it to carry along with it a quantity of air, than they would be, were it to force its way through the tube and air in a separate form.

But, upon the whole, we must allow it to be a subject of considerable obscurity, and further trials may be necessary properly to elucidate the cause.

VI. When we look for the cause of these phenomena, there are two explanations which at once suggest themselves. The one, ascribing the whole to electricity; and the other, to condensed caloric.

The circumstances which lead to the electrical explanation of the phenomena are,

1*st*, The rapidity of the result. This takes place before the least vibration is conveyed to the under end, as is proved by the following experiment:

Exp. 19.—A tin cup, loosely fitted to the bottom of the tube, was filled with gunpowder, and a quantity of the fulminating powder was exploded in the usual way at the top; in this case, the motion of the flame was so instantaneous with the percussion, that the gunpowder was fired before the vibration from the blow could act upon the tin-cup. This was tried in various other ways with the same result.

2*dly*, The colour of the flame much resembling electric light. It is slightly bluish.

3*dly*, There being some similarity in the darting of the light from the bottom of the tube, and the passing of an electric spark upon its discharge.

4*thly*, The odour resembling some of those which arise from actions which have often been called electrical. And,

5*thly*, The fulminating powder employed, containing an electric, which we were entitled to suspect had been brought into rapid excitation by the percussion.

Such, then, being the corresponding appearances of the electric fluid and the flame in question, a number of experiments were tried, with the view of either establishing or overturning this apparent identity. As the results were all unfavourable to the electric theory, an account of three of them may be sufficient.

Exp. 20.—A brass chain was fixed, so as to unite the tube with the ground; under this arrangement, were the flame electric, it must have been conveyed silently by means of the chain to the ground; but this did not take place: the flame still continued to dart forward as formerly at each discharge.

Exp. 21.—When, again, a tube 30 inches in length, was attached to the apparatus, it was found that the discharges of the fulminating powder did not force the flame to the bottom of that tube. Now, had this been the electric fluid, it should have passed along any length of tube with equal facility.

Exp. 22.—A chain was attached to the tube of the apparatus when its length was varied; and this chain was made to communicate with a Leyden phial. After several trials, during each of which repeated discharges of the fulminating powder were made to pass into the tube, it was found, that there was not the slightest indication of the presence of electric fluid in the Leyden phial.

VII. Having found that the first hypothesis does not hold true, we are led to adopt the second, which ascribes the phenomena to condensed caloric.

In the present case, the caloric may arise from one or more of five different sources.

1. It may be disengaged from the fulminating powder, by a change of capacity induced by the blow of the hammer; or probably from a partial decomposition of the union of the substances with their natural caloric.

2. It may arise from the combustion of the ingredients of the powder, in contact with the compressed air.

3. The air of the tube may give out caloric, being condensed by the gaseous bodies liberated at the top.

4. The air in the cap at the top of the tube may give out caloric, when compressed between the cap in the one direction, and the gaseous ingredients of the powder in the other direction. And,

5. The caloric may arise from the rapid movement of the gaseous substances along the brass tube.

Such are the probable sources from which the caloric may be derived; and we may admit that they all so far unite to disengage it.

But, again, when we consider the nature of the caloric, the simplicity of the electric fluid is also lost. The condensed caloric may be attached to some disengaged gaseous fluid; it may proceed by vibrations; or it may exist by itself, quite distinct for the momentary period of its being visible, as it were in an insulated form, somewhat analogous to radiation.

From the various results obtained in a number of experiments, and particularly in some undertaken for the express purpose, I am rather inclined to adopt the last of these conjectures regarding the state in which the caloric exists during its rapid movement. It would be tedious to detail the whole of the experiments which seem to prove this. One, therefore, may be selected, which, of itself, seems conclusive.

Exp. 23.—When we put a piece of tinder into a condensing syringe, and force down the piston, the tinder is inflamed. From this fact it may be concluded, that in the case of Colonel Yule's apparatus, were the flame accompanied by moving air, or were it the result or quality of compressed air, it would inflame a piece of tinder put in any of the joinings of the tube: the experiment was therefore repeatedly tried, using the finest German tinder, but no inflammation took place. To render the experiment more complete, trial was made if the flame would act upon the tinder when in contact with the air at the bottom of the tube, and it was found that it did so.

There are several other circumstances connected with the nature of caloric, which may be so far elucidated by means of this apparatus; but these I shall delay for some future communication, when I hope, by varying the experiments, to make the conclusions more perspicuous.

Explanation of Plate IX.

Fig. 1. Shews the whole of the Apparatus used in Mr Deuchar's Experiments, on a scale of $\frac{4}{11}$ths to 1 inch. AB a thick brass tube, meant to represent the touch-hole of a gun; it is 15 inches long, and can be shortened at a, b, c, and f; C is

a cap which nearly fits A; it is placed at the end of a bar of brass CD, and moves upon a joint at D. I is a piece of cork, to prevent C coming too close upon A, but by its elasticity, to allow it to come close when the blow is given on the top of C. GH is a thick plate of copper to attach CD to the tube AB; and EF is a frame of wood to prevent GH being bent or injured by the discharging the apparatus. KLMN is the canister alluded to in Exp. 3. it is placed in the manner described. OPA is the bent tube used in Exp. 4.

Fig. 2. a section of the cap C, and the steel hammer e, which strikes upon the powder at the top of the tube AB.

Fig. 3. a section of the top A f, and the cup d, for holding the fulminating powder. The bottom piece d f screws out of A, for the purpose of getting it cleaned. The hole of the tube is at *a* separated into three small holes, to prevent the powder falling through.

Fig. 4. the face of the top of A, and the bottom of the cup d, on which is seen the size of the three small holes through which the flame is forced during a discharge.

Fig. 5. the end of one of the divisions of the tube AB, and the size of the male screws which unite them at a, b and c. Into the female screws at a, b and c, were put the gunpowder used in Exp. 18. and the wire gauze in Exp. 13, 14, 15, 16, and 17.

Fig. 6. the bore of the tube AB, and the bottom of the male screws at a, b, c, and the bottom of the tube B.

Fig. 7. The new apparatus freed from the tube, as fitted to and used in discharging the six-pounder. It is screwed to the gun by three nails. C is turned to the muzzle, and D to the breach of the gun. See page 376.

Fig. 8. The corresponding part to A f, Fig. 1., of the apparatus affixed to the six pounder alluded to at page 376. This screws out when the gun is to be cleaned.

Fig. 9. is the bottom of Fig. 8.

Figs. 4. 5, 6, and 9, are of the full size; Fig. 7. is 6 inches long. Fig. 8. is $2\frac{5}{8}$ inches deep. The size of Figs. 2. and 3., which are fitted to each other, will be seen from Fig. 4., which is the face of Fig. 3.

Art. XXVIII.—*On a New Method of Calculating the Parallaxes for Occultations of the Fixed Stars.* By M. Charles Rumker, Rector of the Nautical Academy of Hamburgh. In a Letter to Dr Brewster.

Dear Sir,

In reply to your obliging letter, I take the liberty of communicating to you a new method, of my invention, for calculating the parallaxes for occultations of fixed stars, and in which neither the longitude of the moon nor its augmented semidiameter are required.

Fig. 10. of Plate IX. is an orthographical projection on the plane of the ecliptic, where $k\,n$ is the semidiameter of that circle of latitude of the moon which appears to come in contact with the star, C the centre of the earth, and A the position of the observer on its surface. According to the usual method, we find $DS = BD \mp BS$, where BD is the parallax in longitude, for finding from the true place of the moon's centre, its apparent place, and where BS is found with the moon's augmented semidiameter. I find $DS = SE \mp DE$, where SE is the parallax in longitude, to find from the apparent place of the point of contact on the surface of the moon, or star's place, the true place of that point n of the moon, and where $DE = DCE = \frac{k\,o}{k\,C}$ is found with the true semidiameter of the moon.

Suppose,

L, Longitude } of the star.
b, Latitude }

λ, Longitude } of the nonagesimal.
H, Altitude }

P, Equatorial parallax.

$SE = \pi =$ parallax in longitude for the point n.

B, True latitude of the ☾'s centre.

β, True latitude of that point of the moon behind which the star immerges or emerges.

D, True semidiameter of the ☾.

z, Apparent zenith distance of the star.

p, Parallax in altitude of the point n.

The following is my formula:

$$\cos(L-\lambda)\tan H = \tan M \qquad \frac{\varrho \sin P \sin H}{\cos D}\sin(L-\lambda) = \sin\delta$$

$$\frac{\varrho \sin P \cos H \cos(b+M)}{\cos D \cos M \cos\delta} = \sin\theta.$$

$$\text{Thence}\begin{cases}\sin(b+\theta)\cos\delta = \sin\beta \\ \dfrac{\tan\delta}{\cos(b+\theta)} = \tan\pi = SE.\end{cases}$$

$$DE = \left(\sqrt{\frac{(D+B-\beta).(D-B+\beta)}{\cos B.\cos\beta}}\right).\cos\pi$$

$$SE \mp DE = SD.$$

DEMONSTRATION:

Let $\sin P'$ be $= \dfrac{\sin P}{\cos D}$. Then is $\begin{cases}\sin z.\varrho\sin P' = \sin p \\ \cos z.\cos M = \cos H.\sin(b+M)\end{cases}$

Thence $\dfrac{\tan z.\varrho \sin P \cos H \sin(b+M)}{\cos M} = \sin p;$

but $\tan z.\tan(b+M) = \tan p.\text{cotan}\,\theta.$

Consequently, $\dfrac{\varrho \sin P.\cos H.\cos(b+M)}{\cos M} = \cos\delta\sin\theta.$

Thence π and β are easily deduced.

Now we have $kn = \sqrt{\dfrac{(D+B-\beta).(D-B+\beta)}{\cos B.\cos\beta.}}$; but ko is required.

A n being a tangent, Cn must cut the circle of latitude of the moon in two points, and $ko < kn$. The point n where the observer on the surface of the earth sees the star immerge or emerge, is either hid to the centre of the earth, or falls within the disk of the moon there to be seen; but $ko = kn.\cos nko$, and $nko = CnA = \pi$.

My formula contains nowhere a factor that could become $\frac{0}{0}$. The factors are all sines of great, and cosines of small arcs. On the contrary, the products are all sines or tangents of small arcs. This method can be worked with sufficient exactness with five decimals. I am, &c.

RUMKER.

HAMBURGH,
Feb. 21. 1821.

Art. XXIX.—*On the Movements of Camphor upon Water, and of different Alloys of Potassium when in contact with Water or Mercury.*

The singular movements of small pieces of camphor when floating upon water, have been long ago observed. M. Romieu and other Italian authors considered them as electrical phenomena, while MM. Lichtenberg and Volta, who had seen the same effects in the benzoic and succinic acids, ascribed them to an emanation from these bodies. Brugnatelli discovered, that the bark of aromatic plants, when thrown upon water, moved round like camphor, and Venturi observed an analogous motion in the saw-dust of different woods, that had imbibed either a fixed or a volatile oil.

The last of these philosophers investigated this subject with much attention, and the result of his inquiries is published in a Memoir *, entitled, *Precis de quelques experiences sur la section que des cylindres de Camphre eprouvent à la surface de l'eau, et reflexions sur le mouvement qui accompagnent cette section.* In this paper Venturi shews, that the camphor is rapidly dissolved at the place where it touches the water and the air; that the camphor thus dissolved spreads over the aqueous surface, and is rapidly evaporated by its being thus brought into contact with a greater quantity of air. He then supposes that the jets of dissolution produce, by their mechanical reaction against the camphor, motions of rotation, &c.; and that if the centre of percussion of all the jets do not coincide with the centre of gravity, a rotatory and a progressive motion will result. As the jets are occasioned solely at the circumference of the section of the camphor by the plane of the water, it should circulate round a vertical axis, and small pieces should turn with a greater velocity than large ones.

This interesting subject has received new and important illustrations, in a very able Memoir on the Alloys of Potassium and Sodium, by M. G. S. Serullas, principal druggist to the Military Hospital of Metz, an abstract of which is published

* See *Memoires presentés à l'Institut,* tom i. p. 125. Paris 1805.

in a late number of the *Journal de Pharmacie.* We shall extract from it at present only the parts which relate to the subject of this article.

On the Motions of Alloys of Potassium in contact with Water.

A *fragment of potassium* thrown upon water, turns and agitates itself at the surface like a piece of camphor; but a *fragment of the alloy*, which, being heavier than water, falls to the bottom, does not lead us to anticipate similar motions. M. Serullas, however, observed one of the fragments moving under water in a circular direction; and he remarked that its progress was always opposite to that part of its surface from which the greatest quantity of hydrogen was disengaged,—a result which he presumed was analogous to that which Benedict Prevost ascribed to the effluvia of camphor, and confirmed his opinion in opposition to that of Venturi, Carradori and others.

In order to examine this point, M. Serullas threw some of the alloy, coarsely pulverised, into a mercurial bath, covered with a slight film of water. All these particles, from the variety of their forms, the separation more or less complete of the metallic laminæ which composed them, and which permitted the water to penetrate more or less readily, instantly assumed different motions, more energetic and more varied than those of camphor, but leaving no doubt respecting the analogy of the cause which produced them. In the case of camphor, says M. Serullas, it is an effluvium of its own substance, and in the case of the alloy, it is an effluvium of hydrogen; and in both instances the motion is impaired by the resistance which the effluent matter experiences in the media into which it is projected.

M. Serullas observed, that in proportion as the potassium of the alloy was converted into potash, the debris of the antimony and of the carbon formed at the surface of the bath a species of black unctuous coating, which restrained the motions of the undecomposed fragments. He found, however, that they resumed their wonted vivacity by removing this pellicle; and in order to put into full activity those which had become stationary, and were not exhausted of their potassium, he had only to break them in pieces.

This effect of the pellicle reminded him of that of a drop of oil, which, as Venturi observed, suddenly paralysed the motions of the camphor, when dropped upon any part of the aqueous surface. Dissatisfied, however, with the explanations of this singular fact, M. Serullas supposes, that the camphoric emanation was dissolved by the oily substances expanded over the water, and that this dissolution taking place on every part of the chain, formed by the camphoric molecules, propagates itself more and more, and prevents the reaction which produces the motion. The inactivity of camphor placed upon water impregnated with a fat matter, he explains in a similar manner.

On the Motions of the Alloy of Potassium and Bismuth upon Mercury.

This alloy moves with great volubility on a bath of mercury, whether it be covered with water or not. In both cases it exhales such a strong smell of garlic or phosphorus, that it cannot be ascribed merely to the small quantity of arsenic in the bismuth, but to a particular modification of the hydrogen produced.

M. Serullas remarks, that during the decomposition of this alloy upon mercury, it forms at the surface of the bath a black pellicle, (found by analysis to be a mixture of the oxide of bismuth and charcoal); that this pellicle is attracted by metallic substances, and not by those which are not metallic; that if a plate or rod of zinc, iron, copper, brass, silver, or even bismuth, touches the water of the bath, no attraction is exhibited, but that if it penetrates to the mercury, the black matter springs upon the metal with the rapidity of lightning, and even to a great distance,—a phenomenon which he ascribes to the electric state of the black matter.

The agitation of the alloy of potassium and bismuth, does not appear to him to be owing to the amalgamations of the potassium, but to the disengagement of hydrogen, resulting from the decomposition either of the atmospheric water, whose accumulation round each fragment becomes instantly visible, or of that contained in mercury, more or less moist.

M. Serullas ascribes the impetuosity with which potash moves upon water to the rapid emission of the hydrogen which is produced. In order to prove this, he put portions of the alloy of potassium and bismuth under a receiver of dry atmospheric air, and reversed upon dry mercury, the alloy remained stationary, and was quietly dissolved in the mercury. Other pieces were placed in the same manner under another receiver, and were left for a sufficient time to establish their immoveability. As soon as two drops of water were thrown into the air across the mercury, the fragments began to move with their accustomed velocity. The same effect was obtained by substituting in place of atmospheric air dry azote, or oxygen equally dried. Similar results were obtained by substituting potassium in place of the alloy. M. Serullas now placed a capsule containing mercury, upon which he had put some fragments of the alloy, and having introduced it under the receiver of an air-pump, the fragments instantly expired as soon as the air was withdrawn, and were reanimated by its introduction.

On the Motion of the Alloys of Potassium and Lead, Potassium and Tin, and Potassium and Iron, upon Mercury.

The two first of these alloys are decomposed with difficulty when in contact with water. No doubt, however, the serrated contexture of these metals protects the potassium from the aqueous fluid. When they are thrown on mercury, however, they are soon set in agitation, their motion gradually increases, and they acquire a still greater velocity, if water is poured upon it.

When the alloys have disappeared from the surface of the bath, and have left only a black and unctuous water, M. Serullas observed, that they occasioned starts which raised the pellicle with a species of explosion, and he supposed this to be part of the amalgamated potassium which decomposed the water in the mass of mercury.

M. Serullas likewise remarked, that the alloy of potassium and iron turns like the other alloys upon a bath of mercury covered with water; and he informs us, that all that he has said of the alloys of potassium is equally applicable to those of sodium.

Fig. 1.

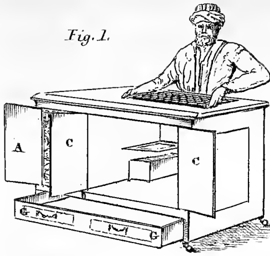


Fig. 2.

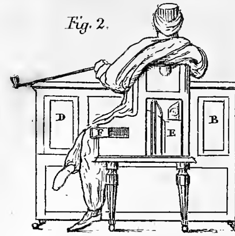


Fig. 3.

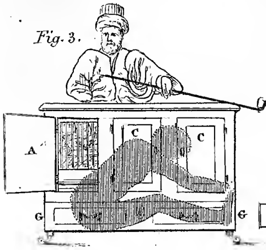


Fig. 4.

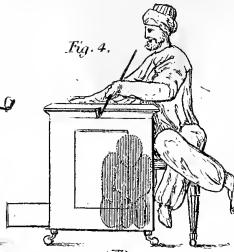


Fig. 5.

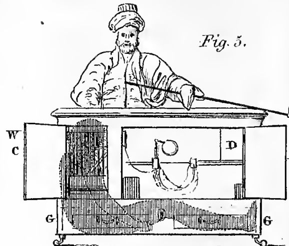


Fig. 6.

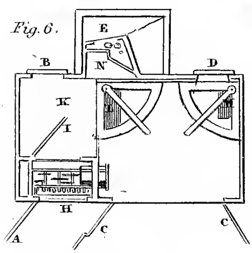


Fig. 7.

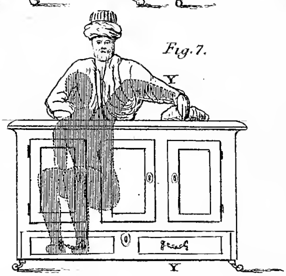


Fig. 8.

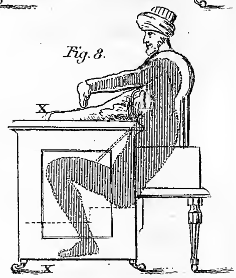


Fig. 9.

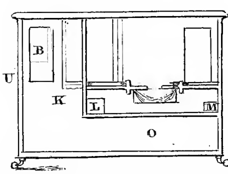


Fig. 10.

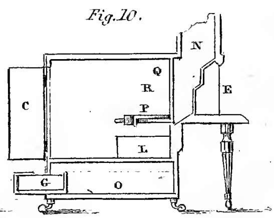


Fig. 11.

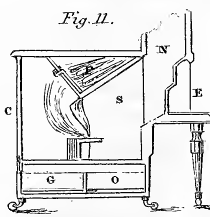


Fig. 12.

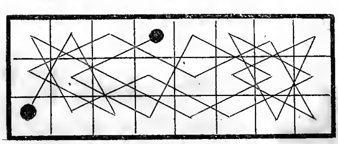
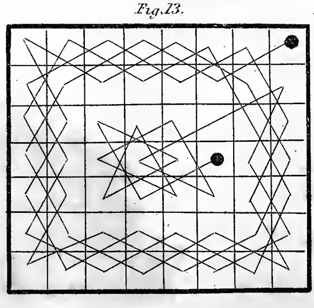


Fig. 13.



Eng.d by W. H. Lizars.

Edinburgh Published by A. Constable & C.o 1821.

Art. XXX.—*An attempt to Analyse the Automaton Chess Player of M. De Kempelen.*

The title prefixed to this article, is that of a very interesting and ingenious little work, just published, which has scarcely reached us in time to enable us to present a satisfactory analysis of it to our readers.

The Automaton Chess Player of Kempelen was introduced into England by its inventor in 1783, and has, during the last two years, been exhibited in various parts of England and Scotland, under the direction of M. Maelzel. The interest which it excited is fresh in our recollection; and the public opinion is pretty equally divided between the two theories, of its being a piece of real machinery, directed by the exhibitor, or a piece of ingenious deception, under the controul of an internal agent. If the impossibility of a chess-player being concealed in the machine had been thoroughly established, we should have had no hesitation in considering magnetism as the moving power; but a very narrow inspection of the apparatus soon satisfies us that there is room for a living being; and that while this appeared to be the case, there was no occasion for calling in the aid of more complex machinery.

The author of the present work has, we think, demonstrated the truth of this opinion, with a degree of sagacity and ingenuity of no ordinary amount; and he has shewn, by a series of drawings, how *a full grown man* may be concealed in the machine, and may take the successive positions which are rendered necessary during the preliminary stratagem, as well as during the progress of the game. We shall endeavour, in the following extracts, to exhibit the principal arguments which he employs.

"The annexed drawings, (Plate X. Figs. 1. and 2.) represent the general appearance of the machine. It runs on castors, and is either seen on the floor when the doors of the apartment are thrown open, or is wheeled into the room at the commencement of the exhibition.

"The exhibitor, in order to shew the mechanism, as he informs the spectators, unlocks the door (A, Fig. 1.) of the chest, which exposes to view a small cupboard, lined with black or dark coloured cloth, and containing different pieces of machinery, which seem to occupy the whole space. He next opens the door (B, Fig. 2.) at the back of the same cupboard, and holding a lighted candle at the opening, still further exposes the machinery within. The candle being withdrawn, the door (B) is then locked. The drawer (G, G, Fig. 1.) in the front of the chest is then opened, and a set of chess men, a small box of counters, and a cushion for the support of the Automaton's arm, are taken out of it. The exhibitor now opens the two front doors (C C, Fig. 1.) of the large cupboard, and the back door (D, Fig. 2.) of the same, and applies a candle, as in the former case. This cupboard is lined with cloth like the other, but it contains only a few pieces of machinery. The chest is now wheeled round, the garments of the figure lifted up, and the door (E, Fig. 2.) in the trunk, and another (F,) in the thigh, are opened. But it must be observed, that the doors (B and D) are closed.

"The chest is now restored to its former position on the floor; the doors in front, and the drawer, are closed and locked; and the exhibitor, after he has occupied some time at the back of the chest, in apparently adjusting the machinery, removes the pipe from the hand of the figure, winds up the works, and the Automaton begins to move."

After pointing out the extreme difficulty of executing the movements of the chess player by machinery alone, and the extreme probability of a deception, from the eagerness of the exhibitor to display a part of the mechanism at one time, and his studied concealment of it at another, our author deduces an argument in favour of his opinion, from the *regular and undeviating mode of disclosing the interior of the chest*; and he shews that the various facts which have been observed respecting *the winding up of the machine*, "afford positive proof that the axis turned by the key is quite free and unconnected either with a spring or a weight, or any system of machinery."

The author then proceeds to point out a method by which any person well skilled in the game, and not exceeding the ordinary stature, may secretly animate the automaton, and imitate the movements of the chess-player. This method will be easily understood from the following extract:

"The drawer (G G, Fig. 10.) when closed, does not reach to the back of the chest; it leaves a space (O) behind it, about 1 foot 2 inches broad, 8 inches high, and 3 feet 11 inches long. This space is never exposed to view.

"The small cupboard is divided into two parts by the door or screen (I, Fig. 6.) which is moveable on a hinge, and is so contrived that when B is closed, this screen may be closed also. The machinery (H) occupies the whole of the front division as far as I; the hinder division is nearly empty, and communicates with the space behind the drawer, the floor of this division being removed.

" The back of the great cupboard is double, and the part (P, Q,) to which the quadrants, &c. are attached, moves on a joint (Q), at the upper part, and forms, when raised, an opening (S) between the two cupboards, by carrying with it part of the partition (R), which is composed of cloth stretched tight. Fig. 10. shews the false back closed. Fig. 11. shews the same raised, forming the opening (S) between the chambers.

" When the trunk of the figure is exposed by lifting up the dress, it will be seen that a great part of it is occupied by an inner trunk (N), which passes off towards the back in the form of an arch, (Fig. 2.) and conceals a portion of the interior from the view of the spectators. This inner trunk opens to the chest by an aperture (T, Fig. 9.) about 1 foot 3 inches high, by 1 foot broad.

" When the false back is raised, the two chambers, the trunk, and the space behind the drawer, are all connected together.

" The player may be introduced into the chest through the sliding panel (U, Fig. 6.), at the end. He will then elevate the false back of the large cupboard, and assume the position represented by the dotted lines in Figs. 3. and 4. Every thing being thus prepared, " the charm's wound up," and the exhibitor may begin his operations by opening the door (A). From the crowded and very ingenious disposition of the machinery in this cupboard, the eye is unable to penetrate far beyond the opening, and the spectator is led to conclude that the whole space is occupied with a similar apparatus. This illusion is strengthened and confirmed by observing the glimmering light which plays among the intricacies of the machinery, and occasionally meets the eye, when the lighted candle is held at the door (B). A fact, too, is ascertained, which is equally satisfactory, though for opposite reasons, to the spectator and the exhibitor, viz. that no opake body of any magnitude is interposed between the light and the spectator's eye. The door (B) must now be locked, and the screen (I) closed, which being done at the moment the light is withdrawn, will wholly escape observation.

" It has been already mentioned, that the door (B), from its construction, closes by its own weight; but as the player's head will presently be very near it, the secret would be endangered, if, in turning round the chest, this door were, by any accident, to fly open; it becomes necessary, therefore, " to make assurance double sure," and turn the key. If the circumstance should be observed, it will probably be considered as accidental, the keys being immediately wanted for the other locks.

" The opening (B) being once secured, and the screen (I) closed, the success of the experiment may be deemed complete. The secret is no longer exposed to hazard; and the exhibitor is at liberty to shape his conduct in any way he may think most likely to secure the confidence of the spectators, and lead them insensibly from the main object of pursuit. The door (A) may safely be left open; this will tend to confirm the opinion, which the spectators probably formed on viewing the candle through this cupboard, that no person was concealed within it: it will further assure them that nothing can pass in the interior without their knowledge, so long as this door continues open.

" The drawer stands next in the order of succession: it is opened, *apparently*, for the purpose of taking out the chess men, cushion, &c. but *really* to allow time for the player to change his position, (see Fig. 5.) and to replace the false back and partition, preparatory to the opening of the great cupboard.

" The machinery is so thinly scattered over this cupboard, that the eye surveys the whole space at one glance, and it might seem unnecessary to open a door at the back, and to hold a lighted candle there, as in the former instance; but the artifice is dictated by sound policy, which teaches that the exhibitor cannot be too assiduous in affording facilities to explore every corner and recess, which, he well knows, contains nothing that he is desirous of concealing.

" The chest may now be wheeled round for the purpose of shewing the trunk of the figure; leaving, however, the front doors of the great chamber open. The bunch of keys, too, should be suffered to remain in the door (D); for the apparent carelessness of such a proceeding will serve to allay any suspicion which the circumstance of locking the door (B) might have excited, more especially as the two doors resemble one another in point of construction.

" When the drapery has been lifted up, and the doors in the trunk and thigh opened, the chest may be returned to its former situation, and the doors be closed. In the mean time the player should withdraw his legs from behind the drawer, as he will not so easily effect this movement after the drawer has been pushed in.

" Here let us pause a while, and compare the real state of the chest at this time, with the impression which, at a similar period of an exhibition of the Chess Player, has generally been left on the minds of the spectators; the bulk of whom have concluded that each part of the chest had been successively exposed; and that the whole was at that time open to inspection: whereas, on the contrary, it is evident that some parts had been entirely withheld from view, others but obscurely shewn, and that nearly half of the chest was then excluded from their sight. Hence we learn how easily, in matters of this sort, the judgment may be led astray by an artful combination of circumstances, each assisting the other towards the attainment of one object.

" When the doors in front have been closed, the exhibitor may occupy as much time as he finds necessary, in apparently adjusting the machinery at the back, whilst the player is taking the position described in Figs. 7. and 8. In this position he will find no difficulty in executing every movement required of the automaton: his head being above the table, he will see the chess-board through the waistcoat as easily as through a veil; and his left hand extending beyond the elbow of the figure, he will be enabled to guide its hand to any part of the board, and to take up and let go a chess man with no other " delicate mechanism" than a string communicating with the finger. His right hand being within the chest, may serve to keep in motion the contrivance for producing the noise, which is heard during the moves, and to perform the other tricks of moving the head, tapping on the chest, &c.

" In order to facilitate the introduction of the player's left arm into the arm of the figure, the latter is obliged to be drawn backwards; and to account for, and conceal this strained attitude, a pipe is ingeniously placed in the automaton's hand. This pipe must not be removed till the other arrangements are completed.

" When all is ready, and the pipe removed, the exhibitor may turn round the winder, to give the impression to the spectators of winding up a spring, or weight, and to serve as a signal to the player to set the head of the automaton in motion.

" The above process is simple, feasible, and effective; shewing indisputably that the phenomena may be produced without the aid of machinery, and thereby rendering it probable that the Chess Player derives its merit solely from the very ingenious mode by which the concealment of a living agent is effected."

The author has added five Lithographic Plates, containing various methods of covering the chess-board with the Knight's moves, both terminable and interminable.

He has given the methods of Euler, Mairan, Demoivre, and Montmort, and has added many new and very beautiful ones of his own. Several of these are upon parallelograms less than the chess-board; two specimens of which are given in Figs. 12. & 13.

Explanation of Plate X.

" Fig. 1. A perspective view of the Automaton, seen in front, with all the doors thrown open.
" Fig. 2. An elevation of the back of the Automaton.
" Fig. 3. An elevation of the front of the chest, the dotted lines representing the player in the first position.
" Fig. 4. A side elevation, shewing the player in the same position.
" Fig. 5. A front elevation, shewing the second position.
" Fig. 6. An horizontal section through the line WW, Fig. 5.
" Fig. 7. A front elevation, shewing the third position.
" Fig. 8. A side elevation of the same position.
" Fig. 9. A vertical section through the line XX, Fig. 8.
" Fig. 10. A vertical section through the line YY, Fig. 7. shewing the false back closed.
" Fig. 11. A similar section, shewing the false back raised.
Figs. 12. and 13. Shew the author's method of covering with the Knight's move parallelograms less than the chess-board.

The following Letters of Reference are employed in all the Figures.

A Front door of the small cupboard.
B Back door of ditto.
CC Front doors of large cupboard.
D Back door of ditto.
E Door of ditto.
F Door in the thigh.
GG The drawer.
H Machinery in front of the small cupboard.
I Screen behind the machinery.
K Opening caused by the removal of part of the floor of the small cupboard.

L A box which serves to conceal an opening in the floor of the large cupboard, made to facilitate the first position; and which also serves as a seat for the third position.
M A similar box to receive the toes of the player in the first position.
N The inner chest, filling up part of the trunk.
O The space behind the drawer.
PQ The false back turning on a joint at Q.
R Part of the partition formed of cloth stretched tight, which is carried up by the false back, to form the opening between the chambers.
S The opening between the chambers.
T The opening connecting the trunk and chest, which is partly concealed by the false back.
U Panel which is slipped aside to admit the player.

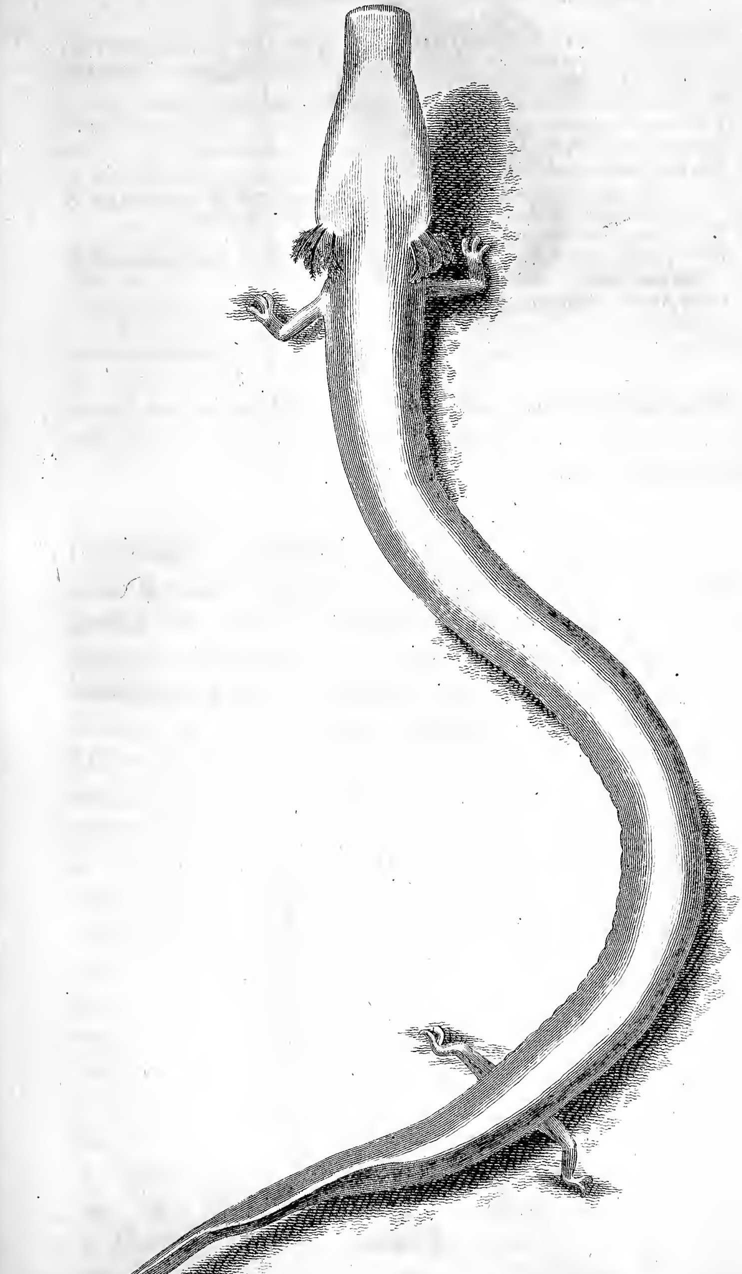
Art. XXXI.—*Observations on the Natural History and Structure of the Proteus Anguinus.* *By* Sig. Configliachi and Dr Rusconi. With a Plate.

The *Proteus Anguinus* is an animal that has much excited the curiosity of zoologists, and many points in its natural history and anatomy still remain undecided. Of late this animal has been examined with far greater minuteness, and under much more favourable circumstances than heretofore, by two Italian naturalists of distinguished ability; and the results of their labours have been given to the world in a work, entitled, "*Del Proteo Anguino di Laurenti Monografia, publicata da Pietro Configliachi, Professore Ordinario di Fisica nella Imperiale Regia Universitá di Pavia, e da Manro Rusconi, Dottore in Medicina e Publico Ripetitore di Fisiologia.*"—*Pavia*, 1819. This work is illustrated by excellent engravings, from most accurate drawings by Dr Rusconi himself; and as only a few copies of it have yet reached this country, perhaps an abridged account of the labours of these ingenious naturalists, which have so much contributed to clear up the doubts respecting this singular animal, may not be unacceptable to such of the readers of the Philosophical Journal as take an interest in such subjects, and have not the opportunity of consulting the original work.

It appears that the first knowledge of this animal was communicated to the public by Dr Laurenti, in his *Synopsis Reptilium*, about the year 1768. A fuller description of it was published by Dr Scopoli in 1772; and in the new edition of the *Systema Naturæ* of Linnæus, edited by Gmelin, notice is taken

PLATE XI.

Edinr. Phil. Jour. Vol.IV.P.398.



W.H.Lizars Sculpt.

Edinburgh Published by A. Constable & Co. 1821.

of it. After this Hermann and Schreibers wrote on the Proteus, but described only its external parts, and contributed nothing to clear up the many doubts and conjectures respecting it. In this state of uncertainty, Dr Schreibers first had recourse to anatomy, as the only satisfactory mode of gaining correct information: but unfortunately he possessed only three Protei, which had been sent to him from Carniola, preserved in spirits; which circumstance precluded him from giving that complete information which might otherwise have been expected from so eminent a naturalist. His description was published in 1801; and among many excellent observations, he points out the striking differences of form in the lungs of the *Sirena lacertina*, compared with those of the *Proteus* *. Next to Schreibers, we have to notice two zoologists of the highest celebrity, MM. Cuvier and Rudolphi, both of whom examined the internal structure of this animal. The former first discovered, and accurately described the organs of generation in the female, and established, on a solid foundation, that the Proteus was not a *larva*, as many had supposed, but a *perfect animal*; an opinion now generally followed, and confirmed by the recent observations of Rudolphi, who has described the generative system in the male, and communicated observations on the globules of the blood, which, in this animal, seem to be of an unusually large size.

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* The authors here observe in a note, that Dr Schreibers, aware of the imperfection of his former description, had lately resumed the subject, and applied himself not less to study the habits than the internal structure of the Proteus. Uninformed of his intentions, the authors had transmitted to him at Vienna a copy of their plates, with the accompanying explanations, and a request that he would favour them with his opinion of their labours, and his advice, where it might appear to him that they had been mistaken. With a liberality that does him great honour, he replied, "Since you have anticipated me, continue the work you have so well begun: when the work shall be published, I will cause a translation of it to be made into our language, under my own eyes, and as I have procured very many of these animals, with the view of instructing myself on various points, I shall be able to add to the translation not a few observations, and perhaps some plates." The authors observe, that they announce, with great satisfaction to zoologists, this intended translation of their work, and the additions it is destined to receive. The fame of Sig. Schreibers renders it unnecessary for them to say more; they add only, that he has devoted many years to this subject, and sacrificed more than 100 protei to his learned researches.

The Proteus Anguinus lives and multiplies in the water of certain subterranean caverns of Carniola. The province in which these caverns occur is divided by a chain of mountains of secondary or *transition* limestone, on which rest many hills of posterior formation. Both in the mountains and hills are many caverns and subterraneous passages stretching in various directions, and lying in different places. These caverns communicate with one another, so that the water first collected in those at a higher level, falls down and circulates through subterraneous channels, till it settles in the lower caverns, some of which are of vast size and depth. Two of the most remarkable of these caverns are situate near Adelsberg, a village lying midway between Trieste and Lubiana. One of them, called the Cavern of Adelsberg, is close to the village, and the other, named the Cavern of Maddalena, is only a few miles distant. It is in this last that the peasants at present go to fish for Protei. On the 2d of August 1816, the authors, attended by three peasants, furnished with torches, and with a small net in the shape of a bag, fixed to the end of a staff, prepared to enter this cavern. At 5 o'clock A. M., the temperature of the external air at the mouth of the cavern was 48° Fahr*. As they descended, they passed through spacious apartments, some of them clothed with stalactites and calc-spar, which reflected with great brilliancy the light of the torches, and exhibited a magnificent appearance. Others appeared like pits of mud, which rendered the walking very inconvenient. At length they reached a stagnant pond, about 30 feet broad, and at a depth below the surface of about 170 toises. In this pond they saw one proteus, but did not succeed in taking him; and from the water being turbid, and in too great quantity, in consequence of heavy rains the day before, they were obliged to reascend, after having been two hours in the cavern, without taking a single proteus. The temperature of the water in this pond was 55°, and that of the air of the cavern was stationary at

* In the original, the temperatures are given according to the scale of Reaumur, which are here converted into the corresponding degree of Fahrenheit. As great precision is not necessary, the nearest *whole* numbers of Fahrenheit are taken, in order to avoid fractions.

54°.5, while the thermometer, left in free air at the mouth of the cavern, had risen from 48° to 59°. The specific gravity of the water in the pond was to that of distilled water, at the same temperature, as 101°.5 to 100°. These animals are found in other pits of stagnant water in Carniola and elsewhere. The first protei described by Laurenti and Scopoli were not procured from the Lake of Zirknitz, as has been commonly represented, nor from any of the caverns of Carniola, but were found accidentally by the peasants in small puddles of water near the mouths of certain caverns, a little distant from Sittich, on the road to Newstadt, in Lower Carniola, cast out of the caverns probably by the overflowing of their water after heavy rains. It was not till the year 1797, that these animals were discovered in the caverns of Maddalena. At present, the peasants of Adelsberg, when the season suits, go to fish for them, and preserve them alive, till they sell them to the curious who visit Carniola, or convey them to Trieste, where they are sold for the small sum of two or three *lire* each.

Regarding the form and habits of the proteus, the authors observe they shall be brief. As to external *form*, the accompanying figure, (Plate XI ,) drawn with all possible care and attention, will much more clearly make it known than any words can do; and on this point, therefore, they profess to note down only such things as could not be exhibited by a figure, or which the draughtsman could but imperfectly represent. With regard to *habits*,—to describe these with minuteness and perfect accuracy, it would be necessary to observe the animal in its native caverns, and not in the state of captivity in which it has been seen by them. They will faithfully state, however, all they have observed of these animals, while kept in vessels within doors for more than two years: and from the observations thus made, and from comparisons between the proteus and aquatic salamander, will deliver the best judgment they have formed of their habits and way of life.

The authors are not able to speak positively either of the age or of the size at which these animals arrive. None of the protei seen by them exceeded 12 inches in length, and the smallest they have heard of was only four *: It was seen by Dr Pockels, a skilful anatomist, and not less estimable for his learning than for the suavity of his manners. There is reason to believe, that, when at their full growth, they reach to 14 inches or even more. That described by Schreibers in 1801 was 13 inches in length. With regard to age, there is reason to think they are pretty long lived; for the Archduke John of Austria, a zealous cultivator and liberal patron of natural science, kept, in a subterranean grotto, constructed for the purpose, several of these animals, one of which lived eight years, and acquired a size greater than ordinary.

When viewed alive, and in water, the body of the proteus appears at first of a cylindrical form, but when more attentively surveyed, it is seen to be somewhat flattened on the sides, especially towards the tail, which, beyond the lower limbs, is reduced at length to the shape of a spatula. The back and head of the animal are of a whitish-red colour, which, on the sides and tail, inclines to violet. The belly, on the contrary, is white, though even there, in the region of the liver, it has a bluish cast, like that of the human veins, seen through a very fine and delicate skin. An illustrious writer, who had observed a proteus only after having been kept in spirits, has described the skin as very opaque; but we, say the authors, who have seen many protei alive, can with confidence affirm, that so far from being opaque, the skin of these animals is, almost beyond belief, transparent,—to such a degree, indeed, that the colours or tints, as painters express it, are so very diaphanous, that, to represent it by words, is quite impossible, and by the pencil sufficiently difficult. Those unacquainted with painting may doubt our assertion, but those the least instructed in that art, and who know by experience how difficult it is to imitate a diaphanous tint, will remain painfully convinced of this, when told that the diaphanity of the tints of the *Proteus Anguinus* (be the human skin as white, morbid, and subtile as you please) exceeds by far that of the colours of the human body. But the flesh-colour of this animal in course of time changes; and this happens more or less quickly, according as he is more or less exposed to the light. From whitish-red the skin passes by

* The authors employ the old French measures.

degrees to violet; so that to preserve the natural colour, it is necessary to keep the animal always in obscurity.

The skin of this reptile, like that of eels, is every where besmeared with a viscid mucus; and when viewed with a lens, it is observed to be studded with minute reddish spots, and with innumerable pores. By reason of this mucosity, the proteus easily slides out of the hand, and while alive, is with difficulty fixed down to any substance for the purpose of dissection. In attempts to do this, say the authors, we have destroyed many protei, and have observed, that, when about to die, the body has become covered with so much mucus, that it appeared difficult to believe how they were able to afford it.

In enumerating the external organs, the authors pass over for the present the eyes and gills, till they come to describe anatomically the organs of sense and of circulation. As to the mouth, it differs from that of other reptiles. The superior lip, after covering the teeth, is continued a little downward over the inferior one in front; and, on the other hand, the inferior lip is continued upward over the superior one on the sides of the mouth. The size of the head and tail is, in some protei, larger in proportion to the body than in others, depending probably on the relative age of the animal, and not on particular seasons, as is the case in the aquatic salamander.

When a proteus that has been kept some time in darkness is observed with caution, he is always found to be resting quietly at the bottom of the vessel, and in the position nearly represented in the figure. But if the vessel be quickly uncovered, he suddenly begins to move, is much agitated, and seeks always that part of the vessel which is darkest. If now that part of the vessel be exposed to the light, the animal again begins to move, and soon his gills assume a redder tint, and the rest of the body also becomes of a redder hue. In fact, the light gives pain, and the animal exerts himself to avoid it. This disposition to escape from light is the more remarkable, as the eyes of this animal are incredibly small, and so buried beneath the skin, that a person even apprized of their situation, must use great diligence to discern them; whence those are not without excuse who have denied altogether the existence of these organs.

This reptile feeds on worms, small bivalves, and snails. In this he resembles the salamander, but he bears fasting much better, being able to live two years and even more without aliment. When taken from his natural habitation, and exposed to the vicissitudes of the season, like other perfect reptiles, he hides himself during winter, is inert, and refuses food.

The proteus does not live long if he is taken out of the water. When he becomes dry, he dies more or less quickly, according as the season is more or less warm, being less able to sustain life under such circumstances than fishes. But if the proteus die more speedily when out of water; in water, on the contrary, he lives better than fishes, since, *cæteris paribus*, he has not such frequent need of a renewal of the water as fishes have. When placed in a small vessel, in water at the temperature of 63°.5, the proteus, like fishes, rises at times to the surface to take in air by the mouth. In doing this, he opens his mouth as wide as he is able, and again rejects the air very quickly through the branchial apertures. In the act of taking in air, and passing it through these apertures, he makes a certain noise, not unlike that made by a syringe, when a little air insinuates itself with the liquid into the tube; but when the animal is removed from the water, and then inspires air by the mouth, this noise is not heard. In the escape of the air by the branchial apertures, when the animal breathes in air, some minute bubbles remain attached to the margins of the apertures, or to the roots of the gills; and the gills themselves collapse and fall down against the sides of the head. On the contrary, when the air is received into the mouth while the animal is in water, it escapes freely through the branchial apertures, and rises in bubbles to the surface.

The necessity of inspiring air from time to time, is more or less great, according as the water is more or less impure; and it has a more direct relation to the temperature than to the quantity of water. It is greatest when the animal is removed from the water; he is then seen to take in air, and reiterate this operation; his breathing becomes weaker, and at the end of two or three hours he ceases to breathe. But if the water of the vessel have the temperature of 63°.5, and be also frequently renewed, he then has no need of rising to the surface to inspire air, and this is still less necessary if the water be in large quantity, or gently flowing. The authors enclosed a proteus in a box, perforated with holes, which was then sunk in a large lake, and kept for three months and a half beneath the surface. At the end of this time, on examining the box, the animal was found extremely lively, which clearly shewed, that submersion in water for so long a period had in no way injured its vital economy. The temperature of the water, through the whole period, varied little from 66°. But if the temperature be under 54°, say from 45° to 48°, it is of little consequence to the proteus whether the water be much or little, fresh or stagnant, since at so low a temperature, he remains always as if immoveable at the bottom of the vessel, and never comes to the surface to inspire air. For four months together, two protei have been kept in a small vessel of water of the temperature from 43° to 45°.5, and have lived very well, although the water has not been once changed.

In the ordinary act of changing the water in which the animals are kept, if the fresh water be of a lower temperature than that which it replaces, the proteus becomes somewhat pale, and the gills, previously of a vermilion hue, turn pale, and collapse in an instant. This observation can, however, be made only in summer; for in winter, when the temperature is from 45° to 48°, if the proteus be placed in obscurity, and left perfectly quiet, the gills are always pallid, collapsed, and very small; and, should he be even molested, they do not appear so branched or red, as we see them when in a temperature varying from 68° to 72°; in which case, if the animal be at the same time well nourished, the gills are always in the erected state represented in the drawing. Should the water be raised successively to 77°, 88°, or 104°, it is observed, that at 88° the animal is much disturbed, expels bubbles of air through the branchial apertures, moves rapidly in the vessel, and attempts to escape: the gills become very red, and are so turgid with blood, that their points are turned upwards. And when the temperature is carried to 104°, the distress of the proteus is very great: he makes such movements and contortions of the body as if about to die, but which soon cease, if the temperature be reduced to its proper point. Hence it seems, that the proteus is not able to live long in a temperature much above 77°.

With regard to the faculties of sense, those of hearing and seeing appear to be very weak; but those of touch and of smell, particularly the latter, exquisitely acute. When some small fishes were put into the vessel containing a proteus, it was amusing to see the animal direct his snout towards his prey, though he could not possibly see it, and afterwards seize it with the greatest celerity when a fish passed near him. But it may be asked, if the sense of sight be so weak, why is it that this animal so anxiously avoids the light? It is probable that the constant desire of obscurity arises from the painful action of light, not on the eye, but on the skin. From the experiments, however, of Sig. Rudolphi, it appears that this animal may, in time, be brought to bear the presence of light.

In a future communication, I propose to exhibit a general sketch of the anatomy of this animal, more particularly of its circulating and respiratory organs, illustrated by a few figures from the beautiful engravings with which the authors have adorned their work. A. Z.

Edinburgh, *January* 20. 1821.

Art. XXXII.—*Description and Use of the Apparatus employed by M. Ampere in his Electro-Magnetic researches.*

Having already laid before our readers a brief account of the researches of Ampere on the mutual action of two electrical currents, we propose at present to give a general description of the very ingenious apparatus which he employed.

The first memoir of this eminent philosopher, a copy of which has just reached us, is entitled, "*On the action exerted upon an electrical current by another current, by the terrestrial globe, or by a loadstone.*"

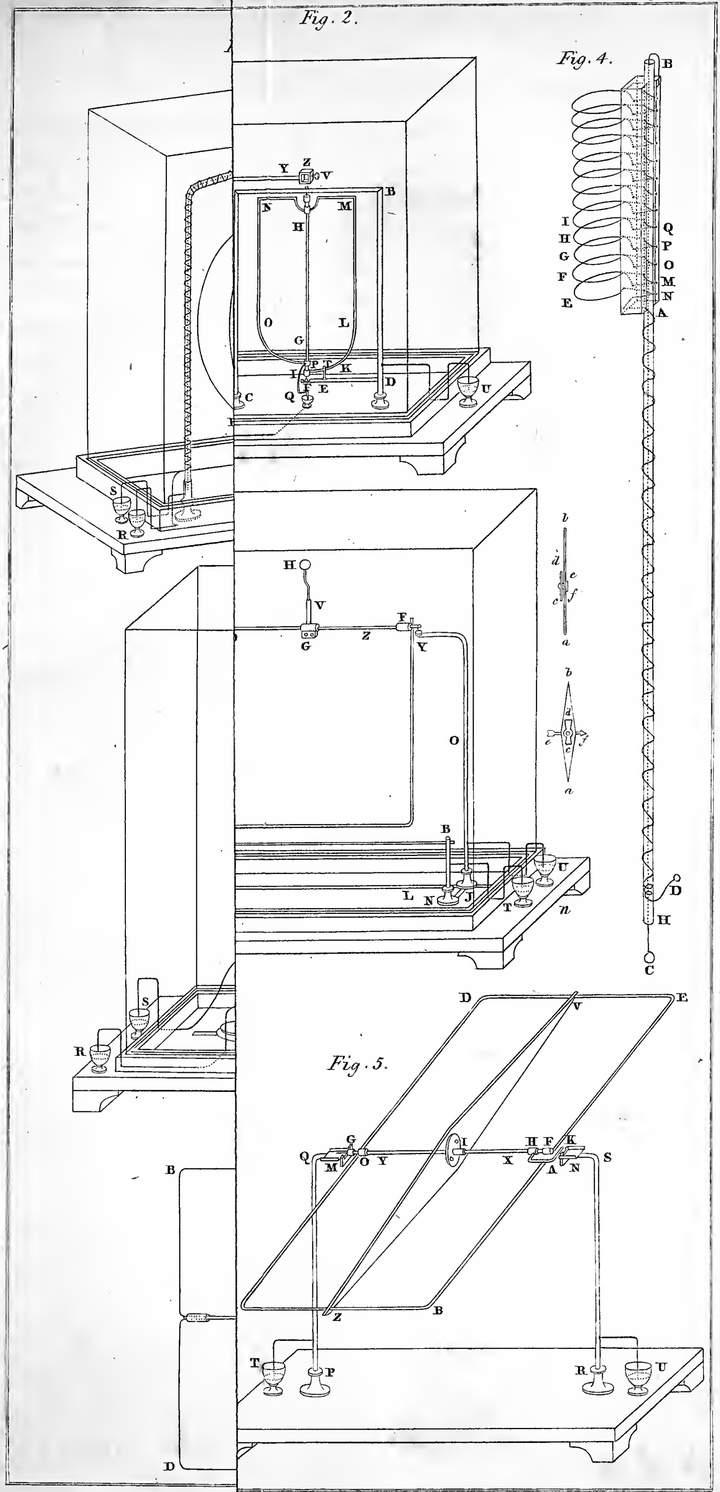
It is divided into three sections,

I. On the mutual action of two electrical currents.

II. On the direction of electrical currents by the action of the terrestrial globe.

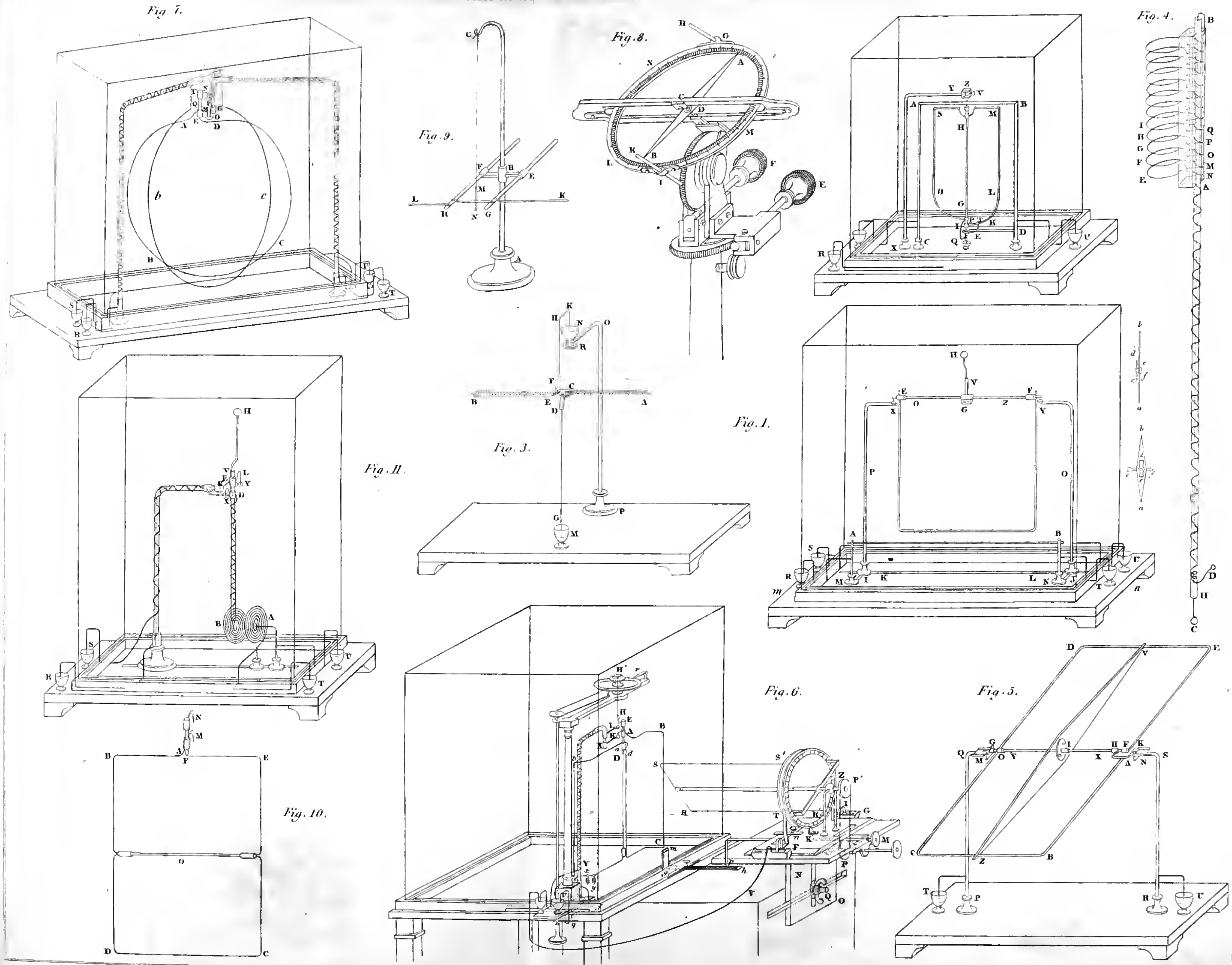
III. On the mutual action between an electrical conductor and a loadstone.

The apparatus which M. Ampere employed in examining the mutual action of electrical currents, is represented in Plate VIII.



W. Archibald Sculp^t

AMPERE'S ELECTRO-MAGNETIC APPARATUS.



W. Archibald Sculpt.

Published by A. Constable & Co. Edinr. 1821.

Fig. 1. It is inclosed in a glass cage, and rests upon a pedestal *m n*. Without this cage are arranged four cups of box-wood, R, S, T, U, for holding the mercury, in which are plunged the brass wires which traverse the cage, and which are soldered to four supports M, N, P, Q, of which M, N, carry the fixed conductor AB, which may be placed nearer to or further from the other, by shifting the supports in the grooves I, J, where they can be fixed by screws under the pedestal *m n*. The other supports P, Q are terminated by steel cups X, Y, large enough to hold globules of mercury which are placed in them, and in which are plunged two steel points attached to copper boxes E, F, which receive the two extremities of a glass tube OZ, having at its middle another copper box, to which is soldered a copper tube V, in which the rod of the counter-weight H slides: This rod is bent, as shewn in the figure, in order to shift the centre of gravity of the moveable part of the apparatus, by turning the bent rod about its own axis in the tube V. The supports P, Q may be placed at different distances, by sliding them in the groove K, L, and may be fixed by screws underneath. To E and F is soldered the brass wire ECDF, the part of which CD, immediately above AB, and parallel to it *, is called the *moveable conductor*.

In using this apparatus, the conductors AB, CD are placed at the required distance, by putting the steel points at E and F into the cups X, Y, and adjusting the counter-weight H. *In order to shew the attraction of two currents when they take place in the same direction*, a communication is then established between the two opposite extremities of the conductors AB, CD, by the bent brass-wires immersed into the box-wood cups, such as R and U, or S and T, which again communicate with the two extremities of the pile by other two brass-wires. *In order to shew the repulsion of the currents*, it is necessary that the first brass-wire establish the communication between two cups, R and S, or T and U, corresponding to the extremities of the two conductors situated on the same side, while a communication is made between the extremities of the pile and the two cups placed on the opposite side. This arrangement of the box-wood cups occurs in most of the other apparatus which is to be de-

* The letters C, D are omitted in the figure, but should be placed at the wire, immediately above AB.

scribed, but it will only be represented in the figures, and not again alluded to.

If the conductor CD, instead of moving parallel to AB, should be made to turn in a parallel plane, and form all angles with AD, the two crossing one another at their middle points, then the two halves of each conductor will attract and repel one another, according as the currents are in the same or in opposite directions; and consequently CD will turn till it has arrived in a situation parallel to AB, when the currents will have the same direction. Hence, it follows, that in the mutual action of two electrical currents, the directive action, as well as the attractive and repulsive ones, depend on the same principle, and are only different effects of one and the same action.

M. Ampere now proceeds to examine the mutual action between an electric current and the terrestrial globe, or a magnet, as well as that of two magnets on one another, and he shews that they are all referable to the law of two electrical currents, by conceiving on the surface and in the interior of a loadstone, as many electrical currents in planes perpendicular to the axis of the loadstone, as we can conceive lines forming without intersections shut curves. He concludes, therefore, *that the phenomena of the loadstone are produced solely by electricity, and that there is no other difference between the two poles of a loadstone but their position with regard to the currents of which the loadstone consists, so that the* SOUTH POLE *is that which is found to the right of the currents, and the* NORTH POLE *that which is found to the left.*

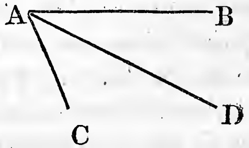
In the apparatus shewn in Fig. 2. of Pl. VIII. the electrical current arriving by the support CA, runs along the conductor AB, and redescends by BDE. The pivot of a glass axis HG turns in the steel cup F, containing a globule of mercury, and the current is communicated from DF to the copper box I, and to the conductor KLMNOPQ, whose extremity Q is immersed in mercury, communicating with the other extremity of the pile. Things being thus arranged, and the conductor LN resting, as in the figure, against the stop T of the fixed conductor CABDF, the current in MN will be contrary to that of AB; whereas by turning KLMNOPQ round a semicircle, the two currents will be in the same direction. The following effect was now produced. The moment the circuit was shut, the moveable part of the apparatus revolved by the mutual action of that part and of the fixed conductor AB, till the currents which were at first in an opposite direction, became parallel, and in the same direction. It passed this last position by its acquired velocity, but soon settled in it after a few oscillations.

The idea of M. Ampere that loadstones are an assemblage of electrical currents, led him to conceive the plan of imitating their action by spiral conductors. After some failures he at last succeeded by means of the following apparatus.

A spiral brass-wire, Fig. 3. Pl. VIII. surrounds two glass tubes ACD, BEF, and being prolonged on both sides, return by the interior of the tubes. The two extremities emerging at D and F, one of them, DG, descends vertically, while the other, FHK, is bent at H and K. Both these wires are terminated by steel points, which are plunged in the mercury contained in the cups M, N, which communicate with the two extremities of the pile, the upper point resting solely on the bottom of the cup N. The extremity of the spiral needle which is to the right of the currents, is that which presents, with regard to a magnetised bar, the phenomena of the north pole of a compass-needle, and the other that of the south pole.

M. Ampere afterwards constructed an apparatus similar to Fig. 1. in which AB and CD were replaced by brass spirals, surrounding tubes of glass, but whose prolongations, instead of returning by these tubes, were put in communication with the two extremities of the pile, like AB, CD.

In using this apparatus, M. Ampere discovered the following law. Let AD be the resultant of two forces AB, AC, and let these lines represent three infinitely small portions of electrical currents, whose intensities are proportional to their lengths. *Then the portion* AD *of the electrical current will exert on another current, or on a loadstone, an attractive or repulsive action, equal to that which would result in the same direction from the reunion of the two portions* AB, AC. Hence, it follows, that in spiral wires, the action produced by the current of each coil is composed of two, one of which would be produced by a cur-



rent parallel to the axis of the spiral, and represented in intensity by the height of the coil, and the other by a circular current, represented by a section perpendicular to this axis in the cylindrical surface on which the spiral is coiled. And as the sum of the heights of all the coils is equal to that axis, it follows, that beside the action produced by the circular transverse currents, which are compared to those of the loadstone, the spiral produces at the same time the same action as a current of equal intensity along its axis.

Now, if the conducting spiral wire returns along this axis, by inclosing it in a tube of glass placed within the spiral, so as to insulate the coils which compose it, the current of the rectilineal part of the wire being in an opposite direction to that which is equivalent to the part of the action of the spiral which is parallel to its axis, the first will repel what the second attracts, and attract what it repels. The longitudinal action of the spiral will therefore be destroyed by that of the rectilineal portion of the conductor, and there will therefore remain only the action of the transverse circular currents, which are perfectly similar to that of a cylindrical loadstone. This reunion exists in the instrument shewn in Fig. 3. which presents exactly the effects of a loadstone, and which will be a valuable instrument in electro-magnetic researches. When the coils have a great height, we have a conductor almost without power.

The phenomena of the loadstone may also be exactly imitated by bending the conducting wire as in Fig. 4. where there is between all the portions of the conductor in the direction of the axis the same compensation which takes place in the spirals already mentioned, between the action of the rectilineal portion of the conductor, and that which the coils exert in a contrary direction, parallel to the axis of the spiral.

In the instrument Fig. 4. the brass-wire contained in the tube BH, is the prolongation of the one which forms the circular rings E, F, G, &c. and each ring is connected with the preceding one by a small arc of a spiral, of which each coil has a great height, in relation to the radius of the cylinder on which it is coiled.

The action exerted by the projections parallel to the axis of the tube of those small spiral arcs marked by M, N, O, &c. being equal and opposite to that of the portion AB of the conductor, there remains in this apparatus only the action of the projections in planes perpendicular to the axis of the tube; and as those of the arcs M, N, O, &c. are very small, we shall have only the actions of the rings E, F, G, &c. remaining.

In order to measure the attractive or repulsive action of two electric currents, as modified by their distance, and by the angles which determine their respective position, M. Ampere employed the apparatus shewn in Fig. 6.

The support KFG has three different motions. The first is produced by the screw M, and the two others by fixing the support to a piece of wood N, which can slide both in a horizontal and vertical direction on another piece of wood O, fixed to the foot of the instrument. In one of these is formed a horizontal groove, and in the other a vertical one, and at their intersection is a screw Q, which fixes the moveable piece in the required position. The rotatory motion of the graduated circle for inclining the portion of the conductor attached to it, is produced by two pullies P and P′. In order that the earth may not affect the moveable conductor, which is balanced by small counter weights x, y, it is composed of two equal and opposite parts ABC *d*, *a b c* DE, shaped as in the figure, in order that its two extremities may communicate with those of the pile. It is interrupted at the angle A, by which it is suspended to a wire HH′, whose torsion ought to balance the attraction or repulsion of the two currents. The branch BA is prolonged beyond A, and the branch DE beyond E, and they terminate by the points K, L, which are plunged in two small cups full of mercury, without reaching the bottom. The foot which carries these two small cups, may be advanced or brought back by means of the screw *q*, which fixes it in the groove *e f*. These cups may be either of iron or platinum. One of them communicates with one of the extremities of the pile by the conductor XU, enclosed in a glass tube, round which is twined a spiral with high coils: The conductor YVT is terminated by a sort of copper spring, which presses by its point at T upon the circumference of the graduated circle, where it is in contact with a circular brass-wire, communicating with the branch S′ S of the conductor, of which the part SR is destined to act as the moveable conductor, and of which the branch R′ R communicates with a second circular brass-wire, on which there presses at Z a spring ZI similar to the first, and which communicates on the side I with the other extremity of the pile. By turning the graduated circle round its horizontal axis, the part SR of the conductor will move in a vertical plane, forming every possible angle with the part BC of the moveable conductor, on which it acts through the glass cage.

In order to place SR at a given distance from BC, the vertical axis H′ H is turned, till BC points to the zero of the scale *gh*, which is done by placing it immediately above the mark on the bevelled extremity of the piece of copper *m*. An index *np*, fixed at *n* to the support of the graduated circle, marks on the scale the distance of BC and SR. When a communication is established between the two extremities of the circuit and those of the pile, BC is carried forward or backward according as it is attracted or repelled by SR, but it is brought back into its former position by turning the axis of suspension H′ H, and the number of turns and portions of a turn marked by the index *r* on the divided circle, gives the value of the attraction or repulsion, as measured by the torsion of the suspending wire.

By the addition of another moveable conductor similarly suspended, and composed of equal and opposite parts, the preceding instrument can measure the momentum of the forces which tend to turn a conductor by the action of another conductor, which forms with it different angles corresponding to different momenta. This moveable conductor ABOCDEF is shewn in Fig. 10. It is suspended between the points A, F, where it is interrupted, and where the two extremities of the conductor carry two steel points M, N, situated in the same vertical line, and plunged in the mercury of the two small cups in Fig. 6., without reaching the bottom. In order to measure the momentum of rotation produced by a rectilineal conductor, one of them is placed under the glass cage, and very near the lower side CD, Fig. 10. of the moveable conductor, so as to be opposite to its middle. This last will then turn by the action of the fixed conductor, without being influenced by that of the earth, because there is a compensation between the action exerted on the two equal and opposite halves of the moveable conductor.

One of the instruments which M. Ampere succeeded in moving by the action of the terrestrial globe, is shewn in Fig. 7., where the conducting wire has the form of a semicircle ABCD, whose radius is nearly 8 inches. The two ends of the brass-wire out of which it is formed, are soldered to two copper-boxes E, F, attached to a glass tube Q, and carrying two steel points M and N, plunged in mercury in the two platinum cups O, P, the upper one, N only, reaching the bottom of the cup P. These cups are carried by the copper-boxes G, H, which communicate with the two extremities of the pile by means of two brass-wire conductors, one of which is contained in a tube of glass carrying these two last boxes, and forming the foot of the instrument; while the other forms around that tube a spiral, whose coils have a sufficiently great height relatively to the diameter of the pile, in order that the actions of the two portions of the currents, which run through these conductors in opposite directions, may nearly neutralise each other.

Under the glass cage which covers the instrument, M. Ampere placed another circle *b c* of brass-wire, whose diameter was a little greater, and which was fixed and supported by a foot similar to that of the moveable circle. This circle communicates also with two conductors disposed in a similar manner, and which serve also to convey the electric current, when, in place of observing the action of the globe upon the moveable circle, we wish to see the action of two circular currents on one another. The circle *b c* indicates the vertical plane perpendicular to the magnetic meridian, into which BC ought to be drawn by the action of the earth. The circle *b c* being placed in this plane by means of a compass, and BC in another situation, for example in that of the magnetic meridian, then, when an electric current is made to pass it, BC will move into the plane indicated by *b c*, and passing a little beyond it by its acquired velocity, will return to it after a few oscillations.

The other apparatus shewn in Fig. 5., consists of a brass-wire ABCDEFG, soldered at A to a piece of similar wire HAK, carried by the glass tube XY by means of the copper box H, and to which is fixed a small steel axis, which rests upon the bevelled edge of a plate of iron N, in which mercury is put in contact with the axis. The part FG of the wire passes into the tube of glass, and is soldered to the copper-box G, to which is attached a small steel axis similar to the other, and resting similarly on an iron plate M. The plates M and N are supported by the feet PQ and RS, which communicate with the mercury in the boxwood cups T, U into which are plunged the two conductors from the two ends of the pile. A thin wooden lozenge ZV, supports the rectangular wire at Z and V, in order to keep it from bending.

In order to observe the effects of the *directive action* of an electric current upon a loadstone, without its being affected by different causes, M. Ampere constructed a needle, which he calls the *Astatic Needle*. This instrument, represented in Fig. 8. consists of a magnetic needle AB, fixed perpendicularly to an axis CD, which can be placed in any direction by the screws and pinions at E, F. The needle thus placed, can only move by turning in a plane perpendicular to this axis, in which its centre of gravity is exactly placed, so that we may be sure, before it is magnetised, that its gravity has no tendency to make it change its position. It is then rendered magnetic, and the instrument serves to prove, that when the plane in which the needle moves is not perpendicular to the direction of the dipping needle, the earth's magnetism tends to make the needle take the direction of the lines traced upon its plane, which are the nearest possible to the axis of the dipping needle, that is to say, the direction of the projection of this axis on the same plane. By means of the screws E, F, the plane in which the needle moves is made perpendicular to the direction of the dipping needle, and the earth's magnetism has then no power to direct it, and it becomes completely *astatic*. The instrument carries in the same plane a graduated circle LMN, on which are fixed two small bars of glass GH, IK, for attaching the conducting wires, whose directing power will act alone, and without complication, along with gravity and terrestrial magnetism.

The principal experiment which is made with this apparatus, is to shew that the angle between the directions of the needle and the conductor, is always a right one, when the *directive action* is the only one which takes place.

The apparatus by which M. Ampere established the existence of an *attractive and repulsive action,* between an electric current and loadstone, without allowing the *directive action* to combine with them, is shewn in Fig. 9., where ABC is a stand, whose arms BEG, BFH, support the horizontal conducting wire KL, near which is suspended a small cylindrical magnetic needle MN, from the point C, by means of a silk fibre, and sometimes by its south, and sometimes by its north pole. With this instrument M. Ampere proves, that when a needle has its axis perpendicular to a conductor, joining the two extremities of the pile, the conductor will attract the loadstone, when its south pole is to the left of the current which acts upon it, that is, when the position is that which the conductor and the loadstone tend to take in virtue of their mutual action, and will repel one another when the south pole of the loadstone is to the right of the current, that is when they are kept in a position opposite to that which they tend to give one another mutually.

In order to prove still more clearly the identity between the currents in voltaic conductors and those in magnets, M. Ampere procured two small and strongly magnetised needles, furnished in the middle with a double brass hook, carrying an arrow, which points out the direction of the current of the magnet. One of these needles is shewn at the right hand side of Fig. 1. where *a b* is the needle, *c d* the double hook, and *e f* the arrow. By means of *c d*, the needles adapt themselves to the conductors AB, CD, Fig. 1. in a situation where the line which joins their poles is vertical, and where their currents, always parallel to the conductors, can be directed either in the same or in opposite directions. Having produced attractions and repulsions between the conductors AB, CD, by making the electric current pass along both, it is then made to pass only along one, and one of the needles is placed on the other, so that the current in the needles is at first in the same direction as it had before been in the conductor to which it is adapted. In this case, we observe the phenomena of attraction and repulsion, which were exhibited by the two conductors. The same needle is then placed so as to have its current in an opposite direction, and the inverse phenomena are observed, in virtue of the same action. If we next stop the electric current in both conductors, and adapt one of the needles to each conductor, they will act upon one another in the same manner as the conductors did upon them.

The apparatus represented in Fig. 11. communicates with the pile, and has its moveable conductor suspended nearly in the same way as in Fig. 1. It differs from it, however, in this, that the two conductors A, B, are here of a spiral form, and the moveable conductor B suspended to a vertical tube of glass. This tube is terminated below, at the centre of the spiral which forms this conductor, and receives in its interior the prolongation of the brass wire of this spiral. When that prolongation reaches D, at the top of the tube, it is then soldered to a copper box F, which carries the copper tube V, into which slides the counter-weight H, and a steel point L, which is plunged in the globule of mercury of the cup Y; whilst the other extremity of the same brass-wire, after having encircled the tube CD in the form of a screw, is soldered to the copper box D, to which is attached another steel point K, to be immersed also in a globule of mercury in the cup X. These two cups are made of steel, in order that they may not be injured by the mercury, and the parts rest on their concave surface, as in Fig. 1.

Scale of the Figures on Plate VIII.

Fig. 1, 2, 3, 5, 9, 10, 11, are drawn in the proportion of *one inch to a foot.*

Fig. 4. is drawn on a scale of *two inches to a foot.*

Fig. 6, 7, are on the scale of *one inch to a foot*, for the parts parallel to the plane of the picture.

Fig. 8. is drawn on a scale of *three inches to a foot*, for the parts parallel to the plane of the picture.

Erratum in Fig. 1. For O (placed above B,) read Q, and insert C at the angle below X, and D at the angle below Y, so that CD may designate the conductor above, and parallel to AB.

Ditto in Fig 6. Insert *e* at the left hand of the dotted line, so that *e f* may mark that line.

Art. XXXIII.—*Quarterly Abstract of the Diurnal Variation of the Magnetic Needle.* By Colonel Beaufoy, F. R. S.

Monthly Mean Variation of the Magnetic Needle.

Variation West.

1820. Oct.	Morning,	24° 39′ 0″
	Noon,	24 39 33
Nov.	Morning,	24 32 23
	Noon,	24 37 38
Dec.	Morning,	24 33 03
	Noon,	24 36 34

Art. XXXIV.—*Analysis of the Transactions of the Royal Society of Edinburgh, Vol.* IX., *Part* I.

The part of the Transactions of the Royal Society of Edinburgh, which has just appeared, contains *Eighteen* papers, and is illustrated with *Thirteen plates.* Several of these communications are of a very popular and interesting nature, and may be perused with much pleasure, even by those who are not in the habit of seeking for amusement or information in the Transactions of learned Societies.

1. *On the Parallel Roads of Lochaber.* By Sir Thomas Dick Lauder, Bart. F. R. S. E.; p. 1.—64. With Eight Plates.

In this curious and interesting paper, the author begins by giving a general description of the form and appearance of the shelves or Parallel Roads:—He next suggests the theory which may account for the formation of such appearances in general:—He then gives a particular account of the whole shelves of Lochaber, as connected with the topography of the glens where they are found, and he concludes by stating the theory which appears most likely to explain the circumstances of their particular formation.

The Parallel Roads, as they are called, are a series of shelves which extend themselves horizontally along the sides or faces of the mountains of Lochaber, particularly those which bound the valleys of Glen Gluoy, Glen Roy and Glen Spean.

The highest of these roads or shelves is observed on each side of Glen Gluoy, and in Glen Roy there are three other shelves, the uppermost of which is about 12 feet below that of Glen Gluoy. The second is about 80 feet lower than the first, and the third about 200 feet below the second. The two upper roads of Glen Roy are confined to that valley, but the lowest extends into Glen Spean and round the upper extremity of Loch Laggan. All these different shelves have corresponding ranges in the opposite sides of the valley on the same level, and by means of careful levelling, they were found to maintain the horizontality characterizing the surface of water throughout all the various windings of their linear extent. And whenever an isolated hill happens to rise from the bottom of the valley above the level of any shelf, a delineation runs round the little hill at a level corresponding to that of the shelf on the mountains which bound the glen.

The formation of these roads has been ascribed by tradition to the Kings of Scotland, when the royal residence was in the Castle of Inverlochy, and also to the Fingalians, in consequence of several of the hills being named after the heroes of Fingal. Sir Thomas Lauder, however, considers these opinions as untenable, and attributes the formation of the parallel roads to the action of the waters of a lake which has stood at different heights corresponding with that of the shelves, and which has subsequently burst through its confining barrier, in consequence of some great convulsion which formed at the same time the great glen of Scotland through which the Caledonian Canal is now carried.

It is very remarkable, that the Parallel Roads should have been so seldom visited even by our own countrymen. If they are works of art, they must possess a high interest in the estimation of the historian and the antiquary; and if they are the result of natural operations, an opinion which we think demonstrable, they afford an ocular proof of a great local convulsion which must have preceded the records of authentic history.

This paper was written before the author had seen the very learned and ingenious Essay of Dr MacCulloch, " On the

Parallel Roads of Glen Roy," published in the fourth volume of the Geological Transactions. The investigations of these able and accurate observers will, we trust, direct the attention of the philosophical geologist to this interesting part of Scotland.

2. *On the Poisonous Fishes of the Caribbee Islands.* By William Ferguson, M. D. F. R. S. E.; p. 65,—80.

An abstract of this paper has already been given, in vol. i. p. 194,—195. of this Journal.

3. *Account of a Mineral from Orkney.* By Thomas Stewart Traill, M. D. F. R. S. E.; p. 81,—93.

An abstract of this paper has already been given in this Journal, vol. i. p. 380.

4. *Extract from an Inspection Report on the Mud Volcanoes of Trinidad.* By William Ferguson, M. D. F. R. S. E. p. 93,—96.

The Mud Volcanoes described in this paper are situated near Point Icaque, the southern extremity of Trinidad. They occur on a round bare platform of several acres, and resemble chimneys like truncated cones, about three feet high, some of which were throwing out, with a strong bubbling noise, salt water, loaded with argillaceous earth. A white sea-shell was observed in the act of being thrown out along with the mud. The mud was always cold. In the hottest months of very dry seasons, the noise is said to be like that of the loudest cannons, and the mud is thrown up to the height of thirty feet.

5. *Memoir on the Repeating Reflecting Circle.* By Major-General Sir Thomas Brisbane, C. B. F. R. S. E.; p. 97,—102.

The observations in this paper, were made with a repeating circle of Troughton's, six *inches radius*, and divided on gold to 20″. For *altitudes*, Sir Thomas chooses thirty repetitions, divided into three series of ten each, and reads the angle or arc run through during the series. For the *time*, he has always found six repetitions, sufficient to give it as correct as equal altitudes; aud of these he generally observes three series in order to take the mean. Troughton's circle, *six inches radius*, gives the same results *to a second*, as a *sixteenth inch* repeating circle, with a moveable axis and level of Reichenbachs. The practical astronomer will find this memoir of great utility.

6. *Description of a Fossil Tree found in a Quarry at Niteshill.* By the Reverend Patrick Brewster; p. 103,—106. With a Plate.

The trunk of this interesting fossil, which was found in the coal-formation near Paisley, was *five* feet long, and had four principal roots, each of which was *two* feet long. The circumference, taken close at the root, was five feet seven inches and a half; in the middle of the stem four feet and a half; and at the top or fracture three feet nine inches.

7. *Account of a non-descript Worm (the Ascaris pellucidus) found in the eyes of Horses in India.* By Alexander Kennedy, M. D. F. R. S. Ed. *With a Description of the Animal.* By Captain Thomas Brown, F. R. S. E.; p. 107, —112.

An abstract of this paper will be found in this *Journal*, vol. i. p. 191, 192. The following is Captain Brown's description of it.

Ascaris *pellucidus.*—Head slightly subulate, with the extremity somewhat obtuse; body smooth, pellucid, of a bluish-white colour; thickest at the centre, and gradually tapering towards the head, and abruptly towards the tail, which terminates in a sharp point; its diameter not being more than one-fourth of the head. Length, $1\frac{1}{4}$ inch.

8. *Memoir relating to the Naval Tactics of the late John Clerk, Esq. of Eldin, being a Fragment of an intended account of his Life.* By the late John Playfair, Esq. F. R. S. Lond. & Ed.; p. 113,—138.

It is scarcely necessary to inform our readers, that the celebrated manœuvre of breaking the enemy's line, by the practice of which we have so often annihilated the proudest armaments of France and Spain, was the undisputed invention of our countryman the late John Clerk, Esq. of Eldin, a country gentleman who had no practical acquaintance with naval affairs. Mr Clerk had begun so early as 1779, to make the principles of his system known to his friends. The manœuvre was first successfully practised by Lord Rodney, in April 1782; and it was by the application of the same principles that Lord Howe, Lord St Vincent, Lord Duncan and Lord Nelson, achieved their splendid victories.

Mr Playfair had proposed to draw up a biographical account of his friend; but he was prevented by ill health from completing his design. Although the present memoir, however, is only a fragment, yet it contains a full account of the great invention of Mr Clerk; and is characterised by the usual elegance and ability of its distinguished author. It will be read, therefore, with the double interest which must ever be excited, to a subject so deeply national, and to the last literary production of a philosopher so universally and deservedly esteemed.

9. *On circular Polarisation as exhibited in the Optical Structure of the Amethyst, &c.* By David Brewster, LL. D. F. R. S. Lond. & Edin; p. 139,—153. With a coloured Plate.

A short analysis of this paper is given in vol. ii. p. 179, 180, the properties of Amethyst detailed in this memoir, will be explained in our general history of the polarisation of light. The author has shewn how to distinguish Amethyst from Quartz, by mineralogical characters, and he has discovered amethyst of a *yellow*, *orange*, *olive-green* and lilac colour, and also *perfectly colourless*, like quartz.

10. *An Examination of some Questions connected with Games of Chance.* By Charles Babbage, Esq. F. R. S. Lond. & Edin; p. 153,—177.

This ingenious and profound paper relates to the methods of betting upon a number of successive events, (the probability of each of which is either equal to, or less than one-half,) by which a profit shall be realised after a considerable number of games have been decided. The simplest plan, called the *Martingal*, is that of doubling the stake whenever a loss occurs; and requires for its success, that the person who employs it, has the power of leaving off whenever he pleases, and has the command of an unlimited capital. If the chance of the events happening is one-third, instead of one-half, the stake must be tripled.

Mr Babbage first examines the case of the Martingal, and then proceeds to other problems of a similar kind.

11. *On the Radiation of Caloric.* By the Reverend THOMAS CROMPTON HOLLAND; p. 179,—185. With a Plate.

In this paper Mr Holland explains in a very perspicuous manner, upon Prevost's Theory, the apparent reflection of cold, and shews why those surfaces which radiate the most caloric produce the greatest cold when cooled, and are most sensible to the impressions either of heat or cold from surrounding bodies.

12. *Notice respecting a Remarkable Shower of Hail which fell in Orkney on the 24th of July* 1818. By PATRICK NEILL, Esq. F. R. S. Ed; 187,—201. With a Map.

An abridgment of this interesting paper is given in the present number, p. 365.

13. *Observations on the Mean Temperature of the Globe.* By DAVID BREWSTER, LL. D. F. R. S. Lond. & Edin; p. 201,—226.

A brief abstract of this paper will be found in vol. iii. of this Journal, p. 376. and vol. iv. p. 193. The general formula for the mean temperature of the globe under all meridians, which is given by the author, is $T = 86° \; 3 \; \text{Sin} \; D. — 3\frac{1}{2}°$, D being the distance of the place from the nearest pole. The position of the two poles of *maximum* cold is in 80° N. Latitude, and 100° West, and 95° East Longitude *. Their mean temperature is —3°$\frac{1}{2}$ Fahr., though it is shewn that the temperatures are best expressed when the Asiatic Pole is taken about 4$\frac{1}{2}$° warmer than the American Pole.

14. *Method of determining the Latitude from Circum-meridian Observations, taken near noon.* By Major-General Sir THOMAS BRISBANE, C. B. F. R. S. E.; p. 227,–235.

By the ingenious method of observing for the latitude, which is described in this memoir, one day's observations will give the latitude within a few seconds, and may be equal to those derived from the chances of three weeks of ordinary weather. The time of noon being ascertained by former methods, Sir Thomas begins nearly 10′ from noon to observe the sun's altitude from an artificial horizon, and continues making as many observations as possible, until the sun has nearly the same altitude as when he began, which will be at 10′ past noon. During these 20 minutes,

* See Plate IV., in which these Poles have been laid down.

an expert observer will easily take 20 altitudes. Two sets of observations from Makerstown, in Roxburghshire, are calculated fully, and accompany the memoir. The following is the result:

10th February, mean of 17 Latitudes,	55° 34′ 18″.6
9th ——— ——— 17 ———	55 34 14.2
Mean Latitude of Makerstown,	55 34 16.4

15. *Description of a Vegetable Impression found in the Quarry of Craigleith.* By THOMAS ALLAN, Esq. F. R. S. Lond. & Ed.; p. 235,–238. With a Plate.

The beautiful vegetable impression described in this paper, belongs to some unknown order of plants. The bark resembles that of a vegetable connected with the palm tribe; but it differs from those commonly met with, by having circular marks arranged in a line along the surface, which appear to be the impressions of flowers or fruit. The specimen is 21 inches long, and 14 broad, and the diameter of the circles a little more than *three* inches. The drawing which accompanies the paper, is from the masterly pencil of R. K. Greville, Esq.

16. *Account of the Native Hydrate of Magnesia, discovered by Dr Hibbert in Shetland.* By DAVID BREWSTER, LL. D. F. R. S. Lond., & Sec. R. S. Edin.; p. 239,–242.

This paper is printed in the present Number, p. 352.

17. *Description of a Magnetimeter, being a New Instrument for measuring Magnetic Attractions, and finding the dip of the Needle, &c.* By WILLIAM SCORESBY, Esq. *jun.* F. R. S. Ed.; p. 243.–250. With a Plate.

An abstract of this paper is published in this Number, p. 360.

18. *Account of the Establishment of a Scientific Prize.* By the late ALEXANDER KEITH, Esq. of Dunottar, in a Letter from the Trustees to Sir WALTER SCOTT, Bart. P. R. S. &c.

See this Number, p. 358.

ART. XXXV.—*Proceedings of the Royal Society of Edinburgh.* (Continued from p. 395.)

Dec. 18. 1820.—THE continuation of the account of the Journey of Alexander Scott through Africa was read. See this Number, p. 225.

At the same meeting were read, Major Rennell's *Observations on the Geography of Scott's Routes in North Africa*, and his *Observations on the currents which carried the Montezuma out of its course.* These two papers are published in this Number, p. 235 and 241.

Jan. 8. 1821.—A paper by Dr Brewster was read, *On the Native Hydrate of Magnesia, discovered by Dr Hibbert in Shetland*; and also an analysis of this Mineral by Dr Fyfe. See this Number, p. 352.

A paper, *On certain Fossil Shells, which retained the marks of their having been in a soft or pliant condition;* by Mr James Flint, Civil Engineer, was read. The specimens described in this paper were from a hill adjoining to the east end of the city of Cincinnati in North America. They were presented to the Royal Society's Museum by Mr Flint.

At this meeting the following gentlemen were elected ordinary members of the Society:

Alexander Oswald, Esq.
James Wedderburn, Esq., his Majesty's Solicitor-General.
Lieutenant-Colonel Straton, C. B., &c. &c.
Dr Graham, Professor of Botany.

Jan. 22.—Mr Scoresby's *Description of a Magnetimeter for measuring the dip of the Needle,* &c. was read. See this Number, p. 360.

Another paper by Mr Scoresby was read, entitled, *A Description of some remarkable atmospherical reflections and refractions observed in the Greenland Seas.* The very curious phenomena described in this interesting paper were observed in the summer of 1820, and were illustrated with accurate drawings.

At the same meeting was read, *A Description of a remarkable Petrifaction found at Craigleith.* By Thomas Allan, Esq. A brief abstract of this paper will be found in p. 423.

Feb. 5.—Colonel Straton read the first part of his paper on the Temples of Egypt, particularly those of Thebes.

The following gentlemen were elected members of the Society:

FOREIGN.

Sir Henry Bernstein.

ORDINARY.

A. N. Macleod, Esq. of Harris.
Sir James M. Riddell, Bart.
Archibald Bell, Esq. advocate.
John Clerk Maxwell, Esq.

Feb. 19.—Dr Andrew Duncan *junior*, read a paper *On Nosographic Lines for exhibiting to the eye the progress of certain symptoms of disease.*

A paper by Hugh Murray, Esq. was read, *On the Encroachment of the Sea on the shores of the Frith of Forth.*

At the same meeting, Dr Kennedy read a *Notice respecting the working and polishing of Granite in India*, which is published in this Number, p. 349.

March 5.—Colonel Straton read the remainder of his paper *On the Temples of Egypt.*

A letter from Major Rennell to Dr Brewster was read, *On the Current of the Lagullus.*

A paper by Dr Brewster was read, *On the Mineralogical Structure of Apophyllite, as detected by the microscope, &c.*

At the same meeting there was laid before the Society drawings and a description of a twenty-five feet Reflecting Telescope, constructed by Mr John Ramage, Aberdeen.

This magnificent telescope, which does honour to Scotland, as well as to its ingenious author, is the largest reflecting telescope, we believe, that was ever constructed, excepting those of the celebrated Sir W. Herschel. The speculum is 25 feet focal length, and 15 inches in diameter. The method of observing is by the front view; the power is from 50 to 1500; and the mechanism by which the observer and the instrument are moved, is so simple and well contrived, that it can be managed and directed to any part of the heavens as readily as a three feet achromatic telescope.

The following gentlemen were elected members of the Society:

FOREIGN.

J. C. Oersted, Secretary to the Royal Society of Copenhagen.

ORDINARY.

The Right Honourable the Earl of Hopetoun.
John H. Wishart, Esq. President of the Royal College of Surgeons.
John Lizars, Esq.
Edward Earl, Esq. Chairman of the Board of Customs.
John Cay, Esq. advocate.

Art. XXXVI.—*Proceedings of the Wernerian Natural History Society.* (Continued from p. 196.)

Jan. 13. 1821.—THE Secretary read two notices, communicated by Dr Colladon of Geneva; one relative to Cinchonine and Quinine, or the alkaline substances existing in cinchona; the other relative to the travels in Brazil of Messrs Spiss and Martius, sent thither by the King of Bavaria.

At the same meeting, Professor Jameson read a notice regarding the existence of Iodine in sponge and in the peat of Scotland, and on the utility of iodine in the cure of goitre. The Professor also exhibited to the Society a section of a log of elm, containing the nest of a titmouse or other small bird, completely encircled by the solid wood of the tree,—the specimen having occurred in one of the Royal Dockyards, and been sent by Lord Melville to Professor Jameson for the Museum of the University of Edinburgh; and the business of the meeting was concluded, by Professor Jameson exhibiting and describing a specimen of the Tapir of India, sent to the Museum by the Marquis of Hastings.

Jan. 27.—This day, a Mummy from Thebes was opened, by direction of Colonel Straton, C.B. of the Eniskilling Dragoons, who brought the specimen from Egypt, and who, being present at the meeting, gave various explanations. A report will be published in regard to this curious remain, which proved to be the body of an individual of the Arab-European race.

Feb. 10.—Professor Jameson read a notice by Mr Blackadder, concerning the sounds emitted by woods or forests on the approach of storms. He likewise gave an account of a very remarkable Scotch terrier. At the same meeting, Mr Deuchar, lecturer on chemistry, continued the detail of his Experiments on the Nature of Flame; an abstract of which will be found in this Number, p. 374.

Feb. 24.—Mr Bald, civil engineer, read an account of the Discovery of an Elephant's Tusk, in the course of excavating the Union Canal, near Linlithgow, with remarks on the nature of the alluvial stratum in which it occurred.

The Secretary read a note, communicated by Mr Trevelyan, of an Experiment made at Howick, in Northumberland, by enclosing a living Toad in a small chamber under ground for the space of more than two years, at the end of which time the animal appeared as healthy as when inclosed.

Art. XXXVII.—*Proceedings of the Cambridge Philosophical Society.*

Nov. 13. 1820.—A Paper by Dr E. D. Clarke was read. In the first part of this paper, Dr Clarke explained, by quotations, the different kinds of pigment used by the ancients in decorating works of art. He afterwards endeavoured to ascertain, on the authority of Pliny, some facts respecting the chemical nature of the substances used in such decorations. The paper concluded, with the detail of certain experiments which led to the discovery of a preparation, which gave to Plaster of Paris Casts the effect of the Rosso-antico Marble.

A notice was read by Professor Lee, *Of the Astronomical Tables of Mohammed Ibn Abibeker al Farsi*, two manuscript copies of which are preserved in the public library of the University. The only previous notice which is to be found of this work, is given by D'Herbelot, and is in many respects erroneous. The Tables are founded on the observations of Al Shirwani, the date of which is the year 541 of the Yezdigerd, and claim to be much more correct than any which preceded them, though it was probably upon some of the earlier ones that the Alphonsine Tables were constructed. After giving a translation of the preface, and a list of the contents of the work, Professor Lee added a Table of the places of the planets for the year 631 of the Yezdigerd, and for the longitude of Sena in Arabia Felix; and another of the latitudes and longitudes of a considerable number of places which are remarkable in oriental geography.

Nov. 27.—A paper was read by Dr E. D. Clarke, *On a Formation of Natron*, discovered by Dr Wavell, in the decomposing stone of the tower of Stoke-Church in Devonshire. It contained a detail respecting the analysis of the native salt, and a description of some peculiarities of the stone, (a variety of greywacke,) in the decomposing cavities of which the salt is now forming.

A Machine was exhibited by the Reverend Mr Cecil of Magdalene College, in which motion was produced by the successive explosions of a body of gas; and a paper, containing an account of the principle and construction of the engine, was read by its inventor. Mr C. stated, that there are two ways in which explosions may be applied to move machinery, either by using the expansive force of the explosion, or by taking advantage of the vacuum which it produces. The contrivance described on this occasion belongs to the latter class. A piston moves in a cylinder; and as it retreats, the space which it leaves is occupied by a mixture of hydrogen gas and atmospheric air. When this mixture has very nearly filled the whole cylinder, the motion of the piston opens a small aperture, through which the flame of a lamp is drawn in, so as to produce an explosion, followed by an instantaneous condensation. The expansion of the gas during the explosion, (by which it is dilated to about three times its original bulk,) is provided for by two other cylinders communicating with the one already mentioned; aud the vacuum produced under the piston continues the motion by means of atmospheric pressure. The author also examined the advantages of this contrivance, the best proportion of the gases, the force of the explosion, and the extent of the expansion, together with some curious irregularities in the working of the machine when the velocity is increased beyond certain limits.

Dec. 11. A paper by Dr Haviland, containing the details respecting the case of a young man who died on the 17th day of a fever of the common continued kind, which was unaccompanied by any unusual symptoms or remarkable affection of the abdominal viscera. An examination was made about twelve hours after death, when the upper and back part of the stomach was found corroded in two places, where the coats of the organ were entirely destroyed. The larger opening communicated with a corresponding hole in the diaphragm, through which the greater part of the contents of the stomach had escaped into the cavity of the thorax. Scarcely any thing had been swallowed by the patient for more than twelve hours preceding his death.

A translation was read by Professor Lee, from an ancient Arabian author on geometry, of a demonstration of the fundamental propositions on the doctrine of parallel lines.

Art. XXXVIII.—SCIENTIFIC INTELLIGENCE.

I. NATURAL PHILOSOPHY.

ASTRONOMY.

1. *Volcanoes in the Moon.*—On the evening of Sunday the 4th of February, when the moon was two days old, Captain Kater, and Mr James Dunlop of Beith in Ayrshire, (well known for his skill in making reflecting telescopes, and other scientific instruments, and who accompanies Sir Thomas Brisbane to New South Wales,) discovered a volcano in the moon, not far from the boundary of illumination. Captain Kater describes the volcano as resembling a small nebula of variable brightness, and subtending an angle of 3″ or 4″. The distance from the edge of the moon was $\frac{1}{1}$th of her diameter; and on the 6th February, the angle which it formed with a line joining the cusps, was about 50°. Mr Dunlop observed it both with a Cassegrainian and Gregorian reflector, and with both it had the appearance of a small luminous spot. Mr Dunlop was not aware till he passed through Edinburgh on the 27th of February, that Captain Kater had made a similar discovery, and had announced it to the Royal Society of London on 15th February. Mr Dunlop observed the very same phenomenon in the year 1817.

2. *Occultation of δ Pisces on the 6th February* 1821.—The subjoined observations on the occultation of δ Pisces by the moon, were made by Colonel Beaufoy, under very favourable circumstances. He paid particular attention to discover if any diminution of the star's light took place on its approach towards the moon's limb; but no such phenomenon was perceptible, and the immersion was instantaneous.

Mean time at Bushey Heath, in N. Lat. 51° 37′ 44″.3, and West Long. in time, 1′ 20″.93.

6th Feb. 1821,	Immersion,	- -	6^h 13′ 28.″7
	Emersion,	- -	7 07 06.7

3. *Elements of the Comet which is expected in* 1822.—This interesting comet, of which we have given a full account in Vol. I. p. 390. of this Journal, is expected to re-appear about

the end of 1821 or the beginning of 1822. In considering the action of the planets upon the comet from 1786 to 1819, M. Encke has found, that Jupiter alone will have any material effect upon the time of the next perihelion in 1822, retarding it more than 9 days, the least distance of the comet from Jupiter being 1,136. The following are the elements upon two hypotheses assumed by M. Encke, the one assigning a period longer by a day than the other:

Passage of the perihelion, mean time at Seeberg, - - -	1822, May 24.	1822, May 25.
Long. Mean Distance, - -	.3472191	.3474612
Long. of the Perihelion from the Mean Equinox, 24th May 1822,	157° 12′ 7″	
Longitude of the Ascending Node, - -	334 23 40	
Inclination of the Orbit, - - -	13 20 36	
Angle of Excentricity, - -	57 38 30	
Daily Motion, - -	1069″49307	1068′59904

From the ephemeris calculated with these elements, it appears that the comet will not be easily seen in Europe till the spring of 1822; but it *may possibly be seen* in December 1821 or January 1822 by very powerful telescopes. In southern latitudes it will be readily seen on the 9th or 10th June 1822, when it will be like a star of the fifth magnitude. On the 1st July it will be brighter than a star of the fourth magnitude. The following are its places in 1822, the mean being taken of the two hypotheses:

Mean Noon at Seeberg.	R. Asc.	Decl.	Comp. brightness.
Feb. 25. -	0° 42′	7° 17′ N.	0.011
Mar. 5. -	4 14	8 49 N.	0.013
April 6. -	22 31	16 13 N.	0.037
May 8. -	54 47	24 18 N.	0.293
June 1. -	91 48	18 40 N.	1.737
—— 17.	107 58	2 15 N.	2.066
—— 25.	119 53	12 42 S.	2.583
July 3.	141 40	33 57 S.	2.723
—— 27.	233 26	47 15 S.	0.385

See the Quarterly Journal of Science, vol. x. p. 413.

4. *New Comet of* 1821.—M. Pons, astronomer royal in the observatory of Marlia, near Lucca, discovered a comet in the constellation Pegasus, on the 21st January, between six and seven o'clock in the evening. This comet seemed to him of a very

extraordinary nature. It appeared like a white spot, of very little density, and without the appearance of a nucleus. It had then only the beginning of a tail, and was not visible to the naked eye. On the 22d January, M. Pons again examined the comet, but what was very singular, it had changed its figure without having changed its place. Though he had not been able on the 21st to take its exact position, yet he had laid down its relative position to the neighbouring stars. Not only was its light more intense, but its tail had changed its shape in the course of a day. It was now two degrees long, and resembled a *jet d'eau.* M. Pons supposed that its light was rapidly increasing, and that it would soon be seen by the naked eye. Astronomers will readily find it in 0° 30′ of right ascension, and 18° of north declination, near χ and u of Pegasus, stars of the sixth magnitude. The preceding comet was re-discovered in this country, by Mr James Veitch of Inchbonny, near Jedburgh, on the 19th of February, when it was distinctly visible to the naked eye, being situated a little to the NW. of Algenib, near to the tip of the wing of Pegasus.

5. *Observations of the Solar Eclipse of the 7th September.*—The following observations of the solar eclipse have been made by Colonel Scherer at St Gall, by MM. Horner and Feer at Zurich, by Oriani at Milan, by Santini at Padua, and by M. Bouvard at Fiume:

	Beginning.	Formation of Ring.	Rupture of Ring.	End.
St Gall,	1^h 19′ 8.″05	2^h 44′ 38″.10	2^h 49′ 1″.88	
Zurich,	1 14 56.6	2 42 3.88	2 43 41.42	4^h 3′ 41″.97
———	1 15 0.39	2 42 15.05	2 43 49.8	4 3 42.67
Milan,	1 22 7.5			4 10 48.7
Padua,	1 36 20.6	3 0 57.2	3 6 14.1	4 24 53.3
Fiume,	-	3 13 31.6	3 18 45.6	4 34 8.6

The Latitude of St Gall is 47° 25′ 40′, and its Long. 7° 2′ E. of Paris.
The Lat. of Zurich is 47° 22′ 27″, and its Long. 24′ 50″ of time E. of Paris.
The Latitude of Fiume is 45° 20′ 10″.

See the *Bibliotheque Universelle, Novembre* 1820, p. 223.

6. *Geocentric Places of Pallas from April* 1. *to July* 30. 1821.—The following geocentric places of Pallas have been calculated by M. Staudt:

Midnight at Göttingen.	R. Asc. in Time.	North Decl.	Midnight at Göttingen.	R. Asc. in Time.	North Decl.
April 1.	16h 44′ 32″	16° 21′	June 4.	16h 12′ 12″	26° 11′
—— 9.	16 48 16	18 17	—— 12.	16 6 0	26 1
—— 17.	16 46 20	20 9	—— 20.	16 0 44	25 31
—— 25.	16 42 56	21 52	—— 28.	15 56 40	24 45
May 3.	16 38 8	23 22	July 2.	15 55 4	24 16
—— 11.	16 32 20	24 35	—— 10.	15 52 56	23 11
—— 19.	16 25 44	25 29	—— 18.	15 52 8	21 57
—— 27.	16 18 52	26 1	—— 30.	15 53 28	19 54

7. *Geocentric Places of Juno, from May 5. to October* 20. 1821. —The following geocentric places of Juno have been calculated by M. Nicolai of Manheim :

Midnight at Manheim.	R. Asc. in Time.	South Decl.	Midnight at Manheim.	R. Asc. in Time.	South Decl.
May 5.	20h 20′ 34″	5° 46′	Aug. 1.	19h 52 23″	5° 17′
—— 13.	20 24 14	5 7	—— 9.	19 45 52	6 10
—— 21.	20 26 43	4 31	—— 17.	19 40 15	7 9
—— 29.	20 27 53	4 1	—— 25.	19 35 56	8 9
June 2.	20 27 57	3 47	Sept. 2.	19 33 10	9 9
—— 10.	20 27 1	3 27	—— 10.	19 32 6	10 7
—— 18.	20 24 39	3 14	—— 18.	19 32 48	11 0
—— 26.	20 20 52	3 12	—— 26.	19 35 13	11 4
July 4.	20 15 48	3 20	Oct. 4.	19 39 17	12 3
—— 12.	20 9 42	3 40	—— 12.	19 44 54	13 8
—— 20.	20 2 55	4 11	—— 16.	19 48 14	13 19
—— 28.	19 55 52	4 53	—— 20.	19 51 54	13 32

8. *Astronomical Society of London.*—The report of this flourishing institution, which has just been printed, is of the most gratifying nature, and will be read with the highest pleasure by every person who is attached to the study of astronomy, or who takes an interest in the public establishments of his country.

The Council have ordered a die to be formed for striking medals in bronze, silver and gold, as a reward for any material discovery or improvement in the science; and they have specified in their report the different points in practical astronomy to which they wish the attention of the candidates to be more particularly directed. The Society's Gold Medal and L. 21 will be given " for the best paper on the Theory of the motions and perturbations of the satellites of Saturn. The investigation to be so conducted, as to take expressly into consideration the influence of the rings and the figure of the planet, as modified by the attraction of the rings on the motions of the satellites; to furnish formulæ adapted to the determination of the elements of their orbits, and the constant co-efficients of their periodical and secular equations, from observation; likewise to point out the observations best adapted to lead to a knowledge of such determination. The papers to be sent to the Society on or before the 1st February 1823." The Council propose that each memoir shall bear a motto, and that a sealed paper, having the same motto, shall contain the name of the author. The sealed papers of the unsuccessful candidates will be destroyed unopened, in the presence of the Council. The remaining part of the Report contains an account of their pecuniary resources, which are in a flourishing state; and a notice of the principal points to which the Council requested the attention of Captain Basil Hall, during his voyage to the South Seas.

9. *Geocentric Places of Ceres and Vesta.*—The following are the geocentric places of Ceres and Vesta for the month of April:

	Ceres.		Vesta.	
	R. Asc.	Decl.	R. Asc.	Decl.
1821, April 1.	16h 33′	14° 37 S.	7h 22′	26° 13 N.
—— 7.	16 33	14 40	7 28	26 3
—— 13.	16 32	14 43	7 34	25 51
—— 19.	16 29	14 45	7 41	25 37
—— 25.	16 27	14 46	7 48	25 22

See the *Phil. Mag.* vol. lvii. p. 129.

OPTICS.

10. *Optical Structure of Melted Quartz.*—In order to decide the important question relative to the existence of *circular* or *rotatory* polarization in the ultimate particles of *Silex*, which had been maintained by M. Biot, as a demonstrated result of his experiments *, I was anxious to examine the optical properties of a piece of quartz-crystal that had been fused. Upon mentioning my wish to our eminent Professor of Chemistry, he kindly supplied me with a piece of considerable magnitude. This piece, which Dr Hope had reduced to fusion by the action of a stream of oxygen, is nearly *two-tenths of an inch* long, and

* See this *Journal*, vol. ii. p. 179, 180.; and the present Number, p. 373.

$\frac{15}{100}$ths of an inch broad. I now placed it in a fluid of the same refractive power, so that I could transmit polarized light through it in every direction, and, upon a careful examination of its structure, I found that it was entirely destitute both of the *ordinary polarizing structure*, and of the *circularly polarizing structure*, having no other action upon light than a piece of well annealed glass. In one corner, a small bubble of air had created, by its expansion, a slight depolarizing structure, such as I have described in this Journal, vol. iii. p. 98. D. B.

11. *Singular Properties of Chlorophæite, found in Scotland and Iceland.*—In the year 1817 I received from Major Peterson, on his return from Iceland, a mass of amygdaloidal rock, containing what he considered a new substance, and which he had observed possessed the singular property of being perfectly transparent, and of a bottle-green colour, when taken out of the rock, but which became quite opaque when removed from its place, or exposed to the air. I was anxious to ascertain whether this remarkable change was an optical or a mechanical one; and the observations I made put it beyond a doubt that it was of a mechanical nature. The cause of this change may be conceived, by supposing a number of prisms assembled in a particular manner, and kept together by screws, so as to bring their touching surfaces into that close contact which prevents total reflection at the junctions. The mass of aggregated prisms will be now quite transparent; but if we either diminish the compressing forces by loosening the screws, or suppose some force similar to the disintegrating force of the atmosphere, to act in opposition to the cohesive force represented by the action of the screws, the touching surfaces will be separated, and the whole mass become opaque. We were not aware till lately, that Dr MacCulloch, in his very interesting work on the Western Islands, had discovered, many years ago, in Fife and in Rum the same substance, to which he has given the name of *Chlorophæite*. He found its specific gravity to be 2.020. It is easily scratched by a quill; is unchangeable before the blowpipe, and is as refractory as quartz. He found it to consist principally of *silica*, and to give indications of a considerable proportion of *iron*, and a little *alumina*. See MacCulloch's *Description of the Western Islands*, vol. i. p. 504. D. B.

MAGNETISM.

12. *Dr Wollaston's Explanation of the Electro-Magnetic Phenomena.*—In the Journal of Science, No. XX., Dr Wollaston is stated to have explained the phenomena of the conjunctive wire, (See this volume of our Journal, p. 407.) upon the supposition of an electro-magnetic current passing round the axis of the conjunctive wire, its direction depending upon that of the electric current, or upon the poles of the battery with which it is connected. This explanation will be understood from Plate VI. Fig. 5., No. 1. and No. 2. In No. 1. the current is represented in two sections, at right angles to the axis of the wires when similarly electrified, from which it appears that the north and south powers meeting, will attract each other. In No. 2., the sections of the wire are shewn dissimilarly electrified, by which similar magnetic powers meet, and consequently repel each other.

13. *Ampere's Electro-Magnetic Telegraph.*—In the curious memoir of M. Ampere, of which we have already given a full account, he proposes to construct a Telegraph, by using as many conducting wires and magnetic needles as there are letters. By placing each letter on a different needle, he establishes, by means of the pile placed far from the needles, an alternate communication betwixt its two extremities and those of each conductor, and thus forms a sort of telegraph, fitted for writing all the details which one may wish to transmit through any obstacle, to a person who is charged with observing the letters placed on the needles. By placing on the pile a row of stops, which would carry the same letters, and establish the communication by their descent, this method of correspondence might be made both easy and rapid.

14. *Cause of the Diurnal Variation of the Needle.*—In the memoir of M. Ampere above alluded to, he ascribes the Diurnal Variation of the Needle to the *alternate change of temperature* of the two regions, during the diurnal rotation of the globe, the influence of temperature on electric actions having been established by M. Dessaignes and others. "We must also add," says he, "among the electro-motive actions of the different parts of the earth, that of

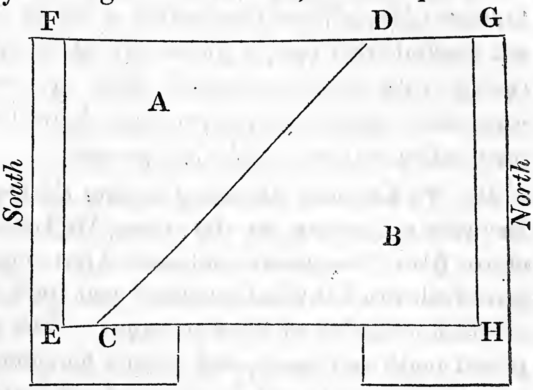
the magnetic minerals which it contains, and which should be considered as so many voltaic piles. The elevation of temperature which takes place in the conductors of electric currents, ought also to take place in those of the terrestrial globe. Is not this the cause of that internal heat in the earth, which has been established by recent observations? And when we consider that this elevation of temperature produces, when the current is sufficiently energetic, a permanent incandescence, accompanied with the most brilliant light, without combustion or loss of substance, may we not conclude that opaque globes are so, on account of the little energy of the electrical currents which are established in them, while those that shine by themselves, derive their light from the more active currents which they possess?"

15. *Mr Lecount's Method of finding the Dip of the Needle.*—In order to measure the dip at sea, Mr Lecount mounts a bar of iron free of magnetism, and about 2 feet long, and upon a stand furnished with a divided quadrant and spirit-level, all the parts of which are either of brass or copper. The stand is then to be placed north and south, and upon a horizontal plane, as ascertained by the level; and, by means of a delicate compass, the bar is examined in different positions, till one side of it is found to be all one pole, and the other side all a contrary pole, and the ends neutral. The divisions on the arc will then give the dip of the needle.—Lecount's *Description of the Changeable Magnetic properties possessed by all Iron bodies*, &c. p. 53. Lond. 1820.

16. *Account of two large Loadstones.*—In a paper giving an account of three large loadstones brought from Moscow, read before the Wernerian Society on 10th March last, Mr John Deuchar gives the following notice regarding two of them: "The largest loadstone weighs 125½ pounds; and it measures in length 10¾ inches, in breadth 8½, and in height 9½ inches. When I received it, it could carry 163 pounds; but, by gradually increasing the weight, I afterwards brought it to support 165 pounds, exclusive of a connecting iron of about 28 pounds, and several supports, which might be 12 pounds more; thus giving an improved power equal to 42 pounds. * The weight of the second loadstone had not been taken previous to fitting on the armature, but it is

* This loadstone is now in the possession of Dr Hope.—Ed.

supposed to be nearly half that of the large one: it measures in length $5\frac{1}{8}$ inches, in breadth 4, and in height about 8 inches. On the 27th November 1818, I had suspended from it a mass weighing 80 pounds, independent of the conducting iron. These two natural magnets were brought to this country in the same vessel: the corresponding poles of both had most probably been placed together, for when they arrived in Edinburgh, the weaker loadstone had its poles changed. A curious fact, which I found exhibited by the largest of these two, deserves particular notice. The full energy of the south pole was not displayed at E, nor did it run along the line E F as is usual, but it was strongest at C, more than an inch from the



south pole, and the force of south attraction ran along the line CD. The north pole, however, was quite correct, being most powerful at H, and along the line HG. This appearance may arise from one of three circumstances: 1st, A may be a mass of ironstone which is not magnetic: 2dly, It may be an ironstone paste, added to complete the shape of the loadstone; or, 3dly, it may be a distinct magnet. If either of the two first suppositions be true, then the power of the loadstone may not be injured by the presence of A; but if the last be correct, then the power must be much weakened. From the external appearance of the loadstone, on both sides of the line of extreme south attraction, I am rather inclined to think that this last is the most likely of the three. If we allow this to be the case, then, by removing A, we must greatly add to the quantity of magnetic effect displayed at the two poles."

ELECTRICITY.

17. *Excitement of Muscular Fibre by Voltaic Electricity.*—The following observations on the subject have been communi-

cated to us by Mr John Murray. " In the *Journal of Science*, No. xix. p. 193, and 194, are detailed some experiments of Configliachi on the excitement of the muscular fibre by voltaic electricity, as modified by the action of poison. In my experiments on the excitability of muscular action by galvanic agency, as modified or suspended by vegetable poisons, detailed in a paper read before the Linnæan Society in 1815, similar phænomena are described. This paper is *now* more interesting than it may have been at the period referred to. For instance, *tincture of opium* applied to the sciatic nerves suspended the excitement, but when *acetic* or other *vegetable acid* was superadded, the susceptibility was restored. Since, then, discovery has announced an *alkali (morphia)* as the active principle in opium, a stranger which this phænomenon might have prepared us to expect. There were numerous experiments of a similar description mentioned, as those with *Atropa belladonna, Hyoscyamus niger*, &c. I subsequently made many experiments on a portion of the *Wild Bushman's Poison*, brought from *South Africa*, and transmitted to me by Mr Campbell. The result of my researches was the discovery of an antidote to that formidable poison. This counter poison was *caustic potassa*. In one of my experiments, a swallow wounded in the thigh by an arrow dipt in the poison was set at liberty, after thirty hours confinement; the arrow being extracted, and the wound washed carefully with the alkali. This was repeated on other animals with equal success. In other cases, this poison, sufficiently rapid in its fatality, was accelerated fearfully by some applications, particularly solution of *chlorine*."

18. *Experiments on the Electric Spark.*—It appears from a statement sent to us by our correspondent Mr John Murray, that the electrical experiment of M. Moll, described in our last Number, vol. iv. p. 200. is only a modification of one published by him in the *Phil. Mag.* for 1815 or 1816, to which the reader is referred.

HYDRODYNAMICS.

19. *Compressibility of Water.*—In examining Mr Perkins' experiments on the compressibility of water, Dr Roget has found, that he has committed a mistake in the calculation, by which he

makes the compression *about* 1 *per cent.* It is actually only $\frac{1}{212.36}$ or a little less than one-half *per cent.* This result agrees most singularly with Canton's experiments, as Dr Roget has shewn; for the modulus of elasticity of water, according to Dr Thomas Young's method, is 750,000, as deduced from Canton's results, while it is 743,260, as deduced from Perkins' results.—See *Ann. of Phil.* Feb. 1821, p. 135.

20. *Perkins' Method of keeping off the Back-Water from Mills.*—At the time of floods, the Back-Water, as it is called, returns upon the water-wheel, and not only diminishes the height of the fall or head of water, but impedes the motion of the wheel, which is necessarily immersed to a certain depth in the back-water. In order to remedy this, Mr Perkins boards up the wheel against the back-water; but leaves a channel at the bottom, through which the back-water would rush upon the wheel, if it were not prevented and driven back by a superior force. This force is obtained, by taking off from the mill-lead a part of the superabundant water, and allowing it to rush by a new channel, through the channel left in the boarding. Its superior momentum drives away the back-water from the wheel, and allows it to perform its functions as freely and uninterruptedly as if there were no flood in the river. This contrivance has been adopted in the United States with complete success for several years.—See the *London Journal of Arts and Sciences*, vol. ii. p. 38.

METEOROLOGY.

21. *Meteorological Table, and Temperature of Springs at Leith for* 1820.—The following meteorological table has been drawn up by Andrew Waddell, Esq. F. R. S. E. from his own observations at Hermitage Hill, near Leith. The mean temperature of 1820 is 47°, and that deduced from springs 47°.3, —agreeing in a very singular manner with the accurate observations of Mr Jardine on the Crawley and Black Springs, which give for the mean temperature of springs at Edinburgh 47°.08, at an altitude of 230 feet. Mr Waddell's observations were made with a register thermometer, situated within three feet of the ground, and placed in the middle of his garden, the surface of

which is 60 feet above the medium level of the sea; Lat. 55°.58 N. and Long. 3°.10 W.

1820, Months.	Mean of greatest Heat.	Mean of greatest Cold.	Mean of both.	Mean range in 24 hours.	Extreme of Heat.	Extreme of Cold.	Mean of ditto.	Mean Temp. of Spring-water from a Pump-well, taken once in Eight Days.
January,	34°.3	26°.3	30°.3	8°.0	50°	4°	27°	
February,	44.5	34	39.2	10.5	54	25	39.5	43°.7
March,	47.7	33.0	40.3	14.7	55	28	41.5	43.5
April,	55.3	43.0	49.1	12.3	70	31	50.0	45.3
May,	59.4	43.5	51.4	15.9	76	36	56	46.5
June,	63.2	47	55.1	16.2	82	41	61.5	48
July,	64	53	58.5	11.0	73	47	60	49
August,	63.7	50	56.8	13.7	72	39	60.5	50.5
September,	61	46	53.5	15	77	39	58	51
October,	50.7	38.5	44.6	12.2	61	32	45.5	50
November,	47.3	37.7	42.5	9.6	56	32	44	48
December,	43	39	41	4.0	56	28	42	46
MEAN,	53.0	41.1	47	12.5	65.1	31.8	49.5	47.3

22. *Mean Temperature at Carlsruhe for 20 years, &c.*—The following results of nearly twenty years' observations have been obtained from the meteorological register kept at Carlsruhe by Professor Böckmann:

MEAN TEMPERATURE from 1800 to 1819.

	Fahr.		Fahr.		Fahr.
1800,	50°.5	1807,	51°.1	1814,	49°.3
1801,	52.7	1808,	48.6	1815,	51.1
1802,	50.7	1809,	50.0	1816,	48.2
1803,	48.9	1810,	49.5	1817,	50.5
1804,	50.0	1811,	52.9	1818,	51.1
1805,	48.4	1812,	48.2		
1806,	52.5	1813,	50.2	MEAN,	50°.23

The following are the monthly mean temperatures from 1800 to 1819:

Jan.	Feb.	Mar.	April,	May,	June,	July,	Aug.	Sept.	Oct.	Nov.	Dec.
32°.2	36°.5	41°.4	50°.4	60°.6	63°.3	66°.4	66°.4	57°.4	50°.4	41°.4	35°.6

Hence the mean temperature of the year is very nearly represented by that of the months of April and October.

The following Table shews the general atmospheric phenomena on a mean of 18 years from 1801 to 1819 :

Days quite clear.	Days quite cloudy.	Varied Days.	Rain.	Snow.	Hail.	Electrical Storms.	Tempests.	Fogs.
38	67	260	136	25	8	19	14	8

The following Table contains the quantity of rain which fell on every square foot :

		In.	Lines.			In.	Lines.
1801,	-	33	8	1811,	-	21	6
1802,	-	24	0	1812,	-	21	0
1803,	-	28	0	1813,	-	25	1
1804,	-	30	1	1814,	-	19	$2\frac{4}{10}$
1805,	-	28	7	1815,	-	19	4
1806,	-	26	6	1816,	-	31	$0\frac{6}{10}$
1808,	-	26	0	1817,	-	26	$5\frac{1}{10}$
1809,	-	25	5	1818,	-	21	$8\frac{4}{10}$
1810,	-	26	0				

The mean of these results is 21.6 inches. The greatest heat which took place was in 1783, on the 3d of August, when it was 98°.9. The greatest cold was — 13°, on the 26th December 1798.—See *Bibliotheque Univers.* Nov. 1820, p. 168,—173.

23. *Meteorological Table kept at Kinfauns for* 1820..—The following Meteorological Table is extracted from the register kept at Kinfauns Castle, North Britain.—Lat. 56° 23′ 30″.—Height above the level of the sea 129 feet.

1820,	Morning, 8 o'clock. *Mean height of* Barom.	Morning, 8 o'clock. *Mean height of* Therm.	Evening, 10 o'clock. *Mean height of* Barom.	Evening, 10 o'clock. *Mean height of* Therm.	Mean Temp. by Six's Therm.	Depth of Rain. In: 100	N° of days. Rain or Snow.	N° of days. Fair.
January,	29.763	29.355	29.776	30.097	30.532	2.30	14	17
February,	29.883	38.655	29.875	39.069	40.310	1.40	12	17
March,	29.761	39.355	29.762	39.645	41.451	0.50	10	21
April,	29.794	45.500	29.795	44.533	47.333	0.90	6	24
May,	29.632	49.516	29.602	47.870	50.741	5.20	19	12
June,	29.838	55.066	29.837	52.966	55.533	1.60	13	17
July,	29.844	57.549	29.788	55.580	59.322	1.80	9	22
August,	29.621	55.645	29.627	53.590	56.806	2.20	13	18
September,	29.792	51.100	29.777	50.060	52.633	1.20	12	18
October,	29.499	43.193	29.480	42.742	44.419	2.50	12	19
November,	29.749	40.633	29.764	40.633	42.133	1.70	11	19
December,	29.877	39.032	29.883	39.129	39.483	2.20	16	15
Average of the Year,	29.754	45.383	29.747	44.659	46.724	23.50	147	219

Annual Results.

Morning.

Observations.	Wind.	Barom.		Wind.	Therm.
Highest, 9th Jan.	SW.	30.88	26th June,	W.	68°
Lowest, 17th Oct.	NW.	28.58	18th Jan.	NW.	1

Evening.

Highest, 8th Jan.	SW.	30.88	25th June,	NW.	67
Lowest, 17th Oct.	NW.	28.66	18th Jan.	NW.	9

Weather.	Days.	Wind.	Times.
Fair, - - -	219	N. & NE. - -	19
Rain or Snow, - -	147	E. & SE. - -	97
	——	S. & SW. - -	67
	366	W. & NW. - -	183
			——
			366

Extreme Cold and Heat by Six's Thermometer.

Coldest, 18th Jan. Wind NW. 1° below Zero.

Hottest, 26th June, —— NW. - 79°

Mean Temperature for 1820, - 46°.7247

Result of Two Rain Guages.	In.
Centre of the Kinfauns Garden, about 20 feet above the level of the sea,	23.5
Kinfauns Castle, 129 feet, - - - - -	18.5

24. *Vegetation on the Himalaya Mountains.*—At the Rol or Shatul pass, over the Himalaya Mountains, the seeds of a species of campanula were gathered at the height of 16,800 feet above the level of the sea, at a spot where the thermometer at noon in the middle of October stood at 27° of Fahr. Shrubs were found in a vegetating state at a still greater altitude.

25. *Mean Temperature of* 1819 *and* 1820 *at Chunar.*—The following observations on the mean temperature of Chunar in Longitude 82° 54′ east, and latitude 25° 9′ north, were made four times a day in a large room, where there were no tatties.

1819,	Fahr.	1819,	Fahr.	1820,	Fahr.
May,	89°	Sept.	82°¼	Jan.	58°
June,	88	Oct.	79¾	Feb.	62½
July,	90	Nov.	69½	March,	77½
Aug.	85½	Dec.	63¼	April,	84
		Mean Annual Temperature,			77°.4

26. *Mean Temperature of Melville Island.*—The following is an abstract of the Hecla's Meteorological Journal for twelve kalendar months, during which period she was within

the parallels of 74° and 75° of north Latitude. The thermometer was placed in the shade on shipboard.

Months.	*Max.* Fahr.	*Min.* Fahr.	Mean. Fahr.
1819, September,	+ 37°	— 1°	+ 22°.54
October,	+ 17.5	— 28	— 3.46
November,	+ 6	— 47	— 20.60
December,	+ 6	— 43	— 21,79
1820, January,	— 2	— 47	— 30.09
February,	— 17	— 50	— 32.19
March, -	+ 6	— 40	— 18.10
April, -	+ 32	— 32	— 8.37
May, -	+ 47	— 4	+ 16.66
June, -	+ 51	+ 28	+ 36.24
July, -	+ 60	+ 32	+ 42.41
August, -	+ 45	+ 22	+ 32.68
	Annual Temperature,		+ 1°.33

" During the time that Captain Parry was in Winter Harbour, it was always found that the thermometer on board stood from 2° to 5° higher than the one on shore, in consequence of the warmth created by the fires, &c. The *minimum* temperature for February was —50° on board, but —55° on the ice. On the 14th and 15 of February, the thermometer was at —54° upon the ice for seventeen hours. The mean annual temperature may therefore be fairly considered as 1° or 2° below zero."—See Captain Parry's Work, and the *Transactions of the Royal Society of Edinburgh*, vol. ix. p. 214.

II. CHEMISTRY.

27. *M. Grotthus's Method of Freezing Water in vacuo the same as Nairne's.*—M. Grotthus has just published, in the *Annales Generales des Sciences Physiques*, by M. Van Mons, &c. &c. the following account of *a New Method of Freezing Water in vacuo*, which is said to be an *improvement* on the method given by Mr Leslie:—" Into a metal vase, half filled with water, I poured, very gently, an equal quantity of ether, so that no mixture might take place of the two liquids. The vase was placed under the receiver of an air-pump, which was so fixed upon its support, as to remain quite steady when the air was pumped out. At the first stroke of the piston, the ether became in a state of ebullition. It was totally evaporated in less than a mi-

nute, and the water *remained converted into ice.* I made this experiment, for the first time, at Mittau, in an apartment, the temperature of which was 16° R. (72° Fahr.)" This method, now held out as an improvement on Leslie's, our readers will observe, (See this *Journal*, vol. iii. p. 59.) is the identical process given by Edward Nairne, so early as 1777.

28. *Solution and Crystallization of Lime.*—It has been some time ago observed by Mr Dalton, that lime was more soluble in cold than in warm water. He found, that one pint of water at 60°, takes up $\frac{1}{778}$ of lime; whereas, one pint, at 212°, takes up $\frac{1}{1270}$: and hence he concludes, that water at the freezing point will dissolve nearly twice the quantity of lime, that water at the boiling point will do. In trying to ascertain the cause of this, Mr R. Phillips found, that the lime deposited by an increase of temperature, was in the state of crystalline particles; that the action of the heat had caused the crystallization of the lime, and had affected it in a much greater degree than could be accounted for by the evaporation which occurred, more than one-half of the lime being crystallized by evaporating $\frac{1}{13}$th of the solution. Mr Phillips' explanation of these interesting facts, though ingenious, does not appear to us satisfactory. See *Ann. of Phil. Feb.* 1821. p. 107.

29. *Mercurial Atmosphere.*—By suspending a piece of gold-leaf in the upper part of a bottle containing mercury, Mr Faraday found that, in about the end of seven weeks, the gold was whitened. Hence he justly concludes, that mercury is always surrounded with an atmosphere of the same substance. *Quarterly Journal*, vol. x. p. 355.

30. *Bicarbonate of Ammonia.*—Mr R. Phillips has found the bi-carbonate of ammonia to consist of

2 atoms Carbonic Acid,	55.08	55.5
1 of Ammonia, -	21.50	21.7
2 of Water, -	22.64	22.8
	99.22	100.0

See *Ann. of Phil. Feb.* 1821, p. 111.

31. *On the Alloys of Platinum.*—The following additional experiments on this subject have been communicated to us by Mr John Murray:

When potassium or sodium is wrapped up in platinum-foil, and introduced into the flame of a spirit-of-wine lamp, it bursts into flame, and perforates the platinum-foil.

When potassium is heated on a slip of platinum-foil, and is withdrawn in a state of fusion, it suddenly ignites the platinum.

If we fold up a fragment of concrete potassa in platinum-foil, and it becomes *anhydrous* by exposure for some time in the spirit lamp, it afterwards burns with scintillation, which seems to be owing to the *reduction of the potassa,* and consequent evolution of *potassium.*

Sometimes when the glowing mass of antimony and platinum falls down, it continues to *burn like a taper* for a short while.

A little powdered *native nickel* from Hesse, or the same in small fragments, folded up in platinum-foil, gave repeated slight explosions like the cracks of a whip; the particles then perforated their envelope, like a sieve, and rolled down through the flame like little fire-balls, in a state of intense ignition.

32. *Composition of Rhubarb.*—Mr Brande has found, that the root of the Rheum palmatum is composed as follows:

Water,	8.2
Gum,	31.0
Resin,	10.0
Extract, Tan and Gallic Acid,	76.0
Phosphate of Lime,	2.0
Malate of Lime,	6.5
Woody Fibre,	16.3
	100.0

Quart. Journ. vol. x. p 291.

33. *On the Colouring Matter of the Shell of the Crab.*—It is well known, that when a crab is boiled, its shell assumes a fine red colour, the nature and origin of which have hitherto been unknown. At the desire of M. Latreille, a series of experiments upon it was undertaken by M. J. L. Lassaigne. The shell of the crab having been carefully freed from all fleshy matter, was plunged in pure alcohol, of the temperature of 59° Fahr. They assumed a scarlet colour, which was instantly communicated to the alcohol. The alkoholic solution of the colouring matter was then decanted, and new doses of alcohol added, till it ceased to be coloured. The shells thus exhausted lost their property of becoming red in boiling water. From the spontaneous evapo-

ration of the different alcoholic solutions, a red and apparently fatty matter was obtained. This matter has no smell, or sensible taste; is insoluble in cold or boiling water, but soluble in sulphuric ether, and pure cold alcohol. This solution is of a scarlet colour. It is not disturbed by the addition of distilled water, which shews that it is not of a fatty nature. Its natural colour is not changed by potash, soda or ammonia. The mineral acids have no action upon it, when diluted with water; but, when concentrated, they destroy it, by changing it to a dirty yellow. The salts of lead, tin, iron, and copper, do not precipitate this colouring matter from an alcoholic solution diluted with water.—*Journ. de Pharmacie*, tom. vi. p. 174,–175.

34. *On the colouring matter of the membrane which lines the shell of the Crab.*—M. Lassaigne also examined the membrane, which, in young crabs, adheres strongly to the shell, but which may be easily separated from it in large crabs. It is extremely fine, and of a violet colour by reflected light, and a purple violet by transmitted light. When put in water it does not lose its colour; but in cold alcohol it gives out a great quantity of red colouring matter, similar to that which is extracted from the shell. Though treated successively with several doses of alcohol this membrane retains a little of its red violet colour, which cannot be taken away from it by other solvents without destroying the membrane itself. The colouring matter has the same properties as that of the shell.

M. Lassaigne has found the same principle in the shells of lobsters, and other animals of the same order, and he concludes,

1. That crabs, &c. contain a red colouring principle, which may be extracted by means of cold alcohol.

2. That this colour is not formed by the action of heat, but that it is developed or distributed in the shell by the impulsion of that fluid.

3. That there exists a highly coloured membrane, which appears to be the source of the colouring matter in that class of animals; and,

4. That this colouring matter differs in its chemical properties from others obtained from the mineral and vegetable kingdom. —See *Journ. de Pharm.* tom. vi. p. 175, 176.

35. *On the Alloys of Potassium and Sodium, with other metals.*—The following are the results deduced by M. Serullas from the elaborate memoir which we have already had occasion to quote, (see page 389.)

1. That very fusible metals, treated in a high temperature with tartrate of potash or soda, are susceptible of producing alloys more or less rich in potassium or sodium, and which may, without being decomposed, resist a very strong fire.

2. That the existence of potassium and sodium in these alloys manifests itself, 1. By the more or less vigorous action which they exert upon water; 2. By the rotation of their fragments in a bath of dry or wet mercury; 3. By the solidification of the mercury which is agitated with them; 4. By the considerable quantity of caloric which they emit, when they are pulverized or exposed to air; 3. That the pyrophorus owes its property of burning in contact with the air to the presence of a certain quantity of potassium.

4. That not only the tartrates, but also the salts whose base is potash or soda, decomposable by heat, are brought to the state of potassium and sodium by means of the charcoal, which is either added or naturally contained in the vegetable acids which form a part of the salts; and that this reduction is singularly favoured, as M. Vauquelin first remarked, by the presence of metals, of which several then join themselves to the potassium or sodium.

5. That the antimony of commerce proceeding from arsenical mines of this metal contains often arsenic, in consequence of the resistance which this last appears to bring to its solidification when it makes part of an alloy.—See *Journal de Pharmacie*, Dec. 1820, tom. vi. p. 589.

36. *Dobereiner on the chemical action of Capillary Tubes.*—M. Dobereiner is of opinion, that chemical combinations and decombinations may be effected by simple capillarity, and he has succeeded in *producing sugar*, by uniting the carbonic acid and carbonated hydrogen, by the aid of charcoal and compression. Experiments of this kind are very dangerous. A strong tube of copper, filled with charcoal, and in which M. Dobereiner had introduced two gases by compression, burst with a tremendous explosion.—*Annal. Generales des Sciences Physiques*, tom. vi. ch. xi.

37. *Existence of Alcohol in Pyrolignous Acid.*—In examining the pyrolignous acid obtained from birch, M. Dobereiner found alcohol in it. Some time after, a manufacturer of salts wrote him from Moscow, that in rectifying wood vinegar, he had collected about a third of brandy. In dissolving large masses of lead in wood vinegar, alcoholic vapours have been observed in such quantities as to deserve being condensed and collected.—*Ibid.*

III. GENERAL SCIENCE.

38. *Mr Campbell's second Journey in Africa.*—The Reverend John Campbell, a native of Edinburgh, who published, some years ago, an account of his travels in the South of Africa, has revisited that part of the world, and penetrated much farther than he did formerly. Upon arriving at Leetakoo, the limit of his former journey, and about 900 miles from Cape Town, he found that the inhabitants had removed to a new settlement, called New Leetakoo. Proceeding N. E. for more than 100 miles, he passed through two towns, one of which, *Masheu*, contained from 12,000 to 15,000 inhabitants, and where much land was under cultivation. Thence he proceeded still farther to the NE. for more than 100 miles, and reached *Kurrechane*, the chief town of the Marootze tribe, containing about 16,000 inhabitants, who have many founderies, and smelt iron and copper ores from the neighbouring mountains. They excel in making baskets, and ornament their walls with paintings of elephants, camelopards, shields, &c. *Kurrechane* is supposed to be in 26° of S. Lat. and not very distant from the eastern coast. Some of the rivers flowed W., and others E. or SS. E. Several large towns are said to be to the east of Kurrechane, and Mr Campbell saw the smoke of one or two of them. He was allowed to send Missionaries to Kurrechane with the promise of protection.—*Lond. Journ. of Science and the Arts*, vol. ii. p. 72 *.

39. *Destruction of the village of Stron.*—The village of Stron, in the district of Fermian in Bohemia, was situated a league

* We have just seen a copper bracelet of very curious workmanship, which Mr Campbell brought from the interior of Africa, which shews their knowledge of the working of metals.—Ed.

above the Saatz on a declivity, partly in the vicinity of the Eger, and partly in a gorge which descended to that river. This hill was formed of a sort of earthy coal, covered with a bed of sand and alluvia. On the upper part of the declivity were several springs, which lost themselves in the small but rugged hills of moving sands upon the banks of the Eger, which flowed at the distance of about 400 yards from the village. These springs appear to have excavated large subterranean hollows, so that the church, the houses and the gardens, rested only on pillars as it were, which became weaker and weaker every day. For some time back, the grand bed appeared to sink in several places; but in the month of February a great noise was heard at midnight; the inhabitants felt that the earth was decending; and they found next morning, that half of the village had disappeared, and had fallen to a considerable distance from the place which it occupied. The hill and the church, indeed, had almost wholly disappeared, and at some distance there was a mass of debris, from which the roof and the chimneys only appeared. The church is now eighty feet below the place on which it was built. It is divided into two parts, one of which is burned, and the spire overturned: only one-fifteenth part of the houses now remain, and even these are not in a state of security. The Eger appears to have undermined, by degrees, the supports of the whole of the hill, which were very much inclined in front.—Gilbert's *Annalen der Physik*, 1820.

40. *Weight of the Dutch Pound Troy.*—In a paper read before the Literary and Antiquarian Society of Perth, on the weight of the Dutch Troy pound, Mr Anderson demonstrated, that the original weight of that pound had been 7680 grains. After stating the theoretical investigation by which he arrived at this result, Mr A. remarked, that it was strongly confirmed by an examination which he entered into some time before, with the view of determining the weight of the Scotch pound, from the various multiples and subdivisions of that weight, in the possession of the Guildry of Perth.

This set of weights, he stated to have been presented by Government to the Guildry of Perth at the time of the Union, and to be uncommonly accurate from the *ounce* to the *stone*, throughout all its denominations, never deviating above *one-tenth of a grain* from what it ought to have been, on the supposition of the pound being 7680 grains. There was another confirmatory circumstance. By James I. it was enacted, that the pint should contain 41 oz. Trone weight, of the clear water of Tay; and by James VI., that the same measure should contain 55 oz. Scotch Troy of the water of Leith. If the water enjoined in the two cases had been the same, the pound Trone would have been to the pound Scotch Troy as 55 to 41; but the specific gravity of the water of Tay being to that of Leith as 100 to 103 nearly, it is a curious circumstance, that if this be taken into account, and the pound Scotch Troy reckoned 7680 grains, the pound Trone will turn out exactly 10,000 grains Troy.

41. *Black Resinous Varnish used at Silhet in Bengal.*—This black varnish, celebrated for its lustre and durability, is prepared in the following manner: the nuts of the *Semecarpus Anacardium*, and berries of the *Holigarna longifolia*, having been steeped a month in clear water, are cut transversely and pressed in a mill. The expressed juice is kept for several months, and the scum taken off from time to time. The liquor is then decanted, and *two* parts of the one are added to *one* part of the other, to be used as varnish. Other preparations are sometimes employed, but the juice of the Semecarpus always predominates. The varnish is laid on like paint, and is polished by rubbing it when dry, with an agate or smooth pebble.—*Quart. Journ.* vol. x. p. 315, 316.

42. *Manufacture of Catgut Strings.*—The catgut strings used for harps and violins, are manufactured at Whitechapel, &c. of the peritorial covering of the intestines of the sheep; but have always been considered inferior to those exported from Italy. Dr MacCulloch ascribes this superiority to the leanness of the Italian sheep,—it is known, that the membranes of lean animals are stronger than those of fat ones; and he suggests, that the catgut should be manufactured from the Welch Highland or Southdown breeds, in preference to those which, like the Lincoln, are prone to excessive accumulations of fat.—*Quart. Journ.* vol. x. p. 267.

43. *On the Selection of Ice for Ice-houses.*—M. Hemptinne of Brussels has shewn, that ice for summer use should be taken from the river on a very cold day, and be exposed on the following

night to the open air, till its temperature is in equilibrio with the cold of the atmosphere. It should then be placed in the ice-house, about six o'clock in the morning, when the air becomes warmer. In order to prove the advantage of that method, he supposes that two ice-houses have been filled with ice, one with ice at 32°, and the other with ice at 14°. When a sixth part of the ice at 32° is melted, the ice at 14° will be untouched, but its temperature will have risen to 32°. One-sixth part of the whole, therefore, has been saved by laying it up at a low temperature.—*Annal. Generales des Science Physiques*, tom. iii. num. 7.

44. *Printing from the Fusible Metal.*—M. Gassicourt proposes to take impressions from recent MSS. by means of the fusible metal. In order to shew the application of it, he pastes a piece of white paper on the bottom of a china saucer, and allows it to dry: he then writes upon it with common writing ink, and sprinkles some finely powdered gum-arabic over the writing, which produces a slight relief. When it is well dried, and the adhering powder brushed off, the fusible metal is poured into the saucer, and is cooled rapidly to prevent crystallization. The metal then takes a cast off the writing; and when it is immersed in slightly warm water, and any adhering gum removed, impressions may be taken from it as from a copperplate.

ART. XXXIX.—*List of Patents granted in Scotland since 23d November* 1820.

11. TO JOHN BIRKENSHAW of Bedlington Iron-Works, in the parish of Bedlington, county of Durham:—For "certain Improvements in the manufacturing and construction of a wrought or malleable iron rail road or way." Sealed at Edinburgh, 30th December 1820.

12. To ANDREW TURNBULL of the Old South Sea House, in the City of London:—For "an improvement in the rudder and steerage of a ship or vessel." Sealed at Edinburgh 30th December 1820.

13. To WILLIAM WOOD of Bow, county of Middlesex:—For "the manufacture of a material or materials for the more effectually making and retaining water-tight and seaworthy ships, and other vessels." Sealed at Edinburgh 30th December 1820.

14. To John Main of Bagnio Court, Newgate Street, London:—For "an improved method of preparing and spinning wool, cotton, silk, flax, fur, and all other fibrous substances." Sealed at Edinburgh 30th December 1820.

1. To John Winter of Acton, county of Middlesex:—For "certain improvements on chimney-caps, and in the application thereof." Dated at Edinburgh 23d January 1821.

2. To John Heard of Birmingham Court, county of Warnock:—For "improvements on working apparatus." Sealed at Edinburgh 23d January 1821.

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