THE

AMERICAN JOURNAL

OF

SCIENCE AND ARTS.

CONDUCTED BY

BENJAMIN SILLIMAN, M. D. LL. D.

Professor of Chemistry, Mineralogy, &c. in Yale College; Corresponding Member of the Society of Arts, Manufactures, and Commerce, and Foreign Member of the Geological Society, of London; Member of the Royal Mineralogical Society of Dresden; of the Imperial Agricultural Society of Moscow; Honorary Member of the Linnæan Society of Paris; of the Natural History Society of Belfast; and Member of various Literary and Scientific Societies in America.

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CONTENTS TO VOLUME XV.

NUMBER I.

INTELLIGENCE AND MISCELLANIES.

I. FOREIGN.

II. Domestic.

NUMBER II.

ERRATA FOR VOL. XV.

Page	132, end of 6th line from top, read *of*.				
"	136, line	8	from	bottom,	for *were*, read *was*.
"	146, "	20	"	top,	after where, read *it*.
"	157, "	14	"	bottom,	for *or*, read *and*.
"	204, "	10	"	"	for *metals*, read *metal*.
"	209, "	15	"	bottom,	for *stone*, read *clove*.
"	211, "	19	"	"	" *lows*, read *bows*.
"	213, "	7	"	"	after them, for . read , and for *S*, *s*.
"	233, caption, for Vol. IV, read Vol. XIV.				
"	234, line 4 from bottom, after moisture, add "				
"	237, bottom line, for *Mr.* read *Mc*.				

The following are variations from MS. ordered by Mr. Eaton—some of them, as he states, errors of the amanuensis.

Page	254, line	15	from	bottom,	for *contiguous*, read *continuous*.
"	248, "	18	"	"	for *polytichum*, read *polytrichum*.
"	244, "	5	"	"	omit *at both these localities*.
"	" "	6	"	"	for *saturation*, read *solution*.
"	" "	12	"	top,	after *has*, read *however*.
"	" "	17	"	"	after *speculation*, read *made by authors*

CONTENTS.

INTELLIGENCE AND MISCELLANIES.

I. FOREIGN.

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

Art. I.—*On the Muriate of Soda, or Common Salt, with an account of the Salt Springs in the United States; by* George W. Carpenter, of Philadelphia.

There is perhaps no individual article more important or indispensable for the support of the animal creation than common salt; and, the Creator, in his arrangements for the comfort, happiness, and sustenance of man, has placed, in the most systematic and best adapted order—in situations easily accessible, and in astonishing profusion, the substances most essential to the support and comfort of human life; hence we find salt, iron, coal, limestone, &c. to be almost universally distributed over the surface of the globe in large quantities, and in the most accessible situations; whilst the less useful bodies, as gold, silver, diamonds, &c. exist in minute quantities, and often in places not to be explored without great labor and expense. Salt, as before observed, exists in immense masses or beds, either at the surface of the earth, or at a great depth below the soil. It has been found in regions much elevated above the sea, and in some instances it constitutes whole mountains of very considerable altitude. The ocean however is the greatest depository of salt; nearly one-thirtieth part of the whole weight of the waters of the ocean is muriate of soda. Other salts, viz. the muriates both of lime and magnesia, and the sulphate of soda, exist in the waters of the ocean. According to La Place, the average depth of the ocean is ten miles; were the water evaporated, the salt would form a bed of seven hundred feet in thickness, a mass sufficient to cover all the present dry land with salt to the depth of two thousand feet; and as the ocean has once covered our present continents, we need not be surprised at the quantity of rock salt found in various parts of the globe.* The proportion of salt contained in the water is, with few exceptions, nearly the same in all latitudes. The Baltic is much less salt than the ocean, and contains, when an easterly wind prevails, only $\frac{1}{108}$ part of saline matter. The Dead Sea of Palestine is an exception of the opposite kind. According to Gay Lussac, one hundred parts of this water contain muriate of magnesia 15·3, muriate of soda 6·9, muriate of lime 4·0.† It is stated in the first volume of Romé de l'Isle's Crystallography, page 375, that the salt water in the Baltic sea contains $\frac{1}{64}$ part of its weight of salt; that of the sea between England and Flanders contains $\frac{1}{32}$ part; and that of the coast of Spain one ounce in the pound; and that between the tropics one ounce and a half or even two ounces, viz. one-eighth of the whole. From this may be seen the great advantage of separating the brine of the sea water in cold climates by freezing before it is set over the fire for evaporation.

Rock salt is found very high above the level of the sea, as in the Cordilleras of America, and also in Savoy, where it exists at an elevation equal to that of perpetual snow.

Salt fountains are very common in various parts of Europe and elsewhere, so that hardly any kingdom is absolutely without salt either in mines or springs. Salt springs are found in Lorraine, Alsatia, Franche-Compté and Gascony, provinces of France, in the Palatinate of the Rhine, Spire, Hesse, and Luneburg, in Germany; Halle in Saxony, in Ostrogothland, Westmanland, &c. &c.‡ From the salt springs at Droitwitch, in Worcestershire, sixteen thousand tons of salt are annually procured, and one hundred and fifty-six thousand tons of rock salt are annually raised from the great deposit near Northwitch, in Cheshire. In France there are many salt springs, but no known deposit of solid salt. Sweden and Norway are without salt. It is abundantly diffused through many countries of Asia, Africa, and America.

The most celebrated salt mines in Europe are at Cardona in Spain, and in Poland. The former appears to be an enormous mass of salt that probably once formed the bottom of the lake. Through this mass the water has excavated a valley, leaving several detached mountains of salt, that were

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* Bakewell's Mineralogy, page 637. † Cleaveland's Mineralogy, page 128.
‡ Cronsted's Mineralogy, Vol. 1, p. 361.

probably harder than the other parts. There is an extensive formation of rock salt on each side of the Carpathian mountains for six hundred miles, from Weleiska in Poland to Rimmie in Moldavia. Rock salt and salt springs most generally occur near the feet of extensive mountain ranges, which adds probability to the opinion that these ranges were once boundaries of extensive lakes of salt water. In some parts of Africa there are salt lakes which rest on beds of solid rock salt: these beds were probably formed by fresh depositions of salt as the water evaporates. Near Algiers the salt lakes are dried up in summer, and leave immense masses of rock salt at the bottom.

The lake Yelta, beyond the river Volga, supplies all Russia with salt.*

Muriate of soda is most generally associated with beds of clay, which frequently alternate with those of the salt; sand, sandstone, and compact, fetid and bituminous limestone usually accompany the deposits of salt. But the most intimate connexion exists between this salt and the sulphate of lime or gypsum, over which the beds are usually placed, or sometimes they even alternate with it. The constant occurrence of the muriatic and sulphuric acids in the same situations is an interesting fact, which, in a more advanced state of chemical and geological science may serve to elucidate the formation of gypsum and rock salt.

In the *United States*, salt springs are very numerous. They sometimes flow naturally, but are generally formed by sinking wells in those places where salt is known to exist, as in certain marshes, salt licks, &c.

The country on the Arkansas river furnishes some salt; it differs, however, from most other places in the United States, by existing in pools, and forming incrustations on the soil of plains and prairies. There is no salt obtained in Arkansas by boring, the usual mode of procuring it in other localities.

There are many salt springs in Missouri; the working of many of them, however, has been suspended or entirely relinquished, in consequence of the reduced price of the salt. The principal one now in operation is at Boon's Lick.

There are no salt works in operation on the Wabash. There is one manufactory in operation at Tohota, on a trib-

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* Philosophical Transactions, Vol. 77, and Foster's Introduction to Mineralogy, page 32.

ütary of the Wabash. Salt springs are worked at Sciota; the quantity yielded, however, is comparatively small. There are no salt works on the Tennessee river, but on the Holston, a tributary to the Tennessee river, are extensive salt springs, situated near Abingdon, Virginia, known by the name of King's and Preston's salt works. These springs yield a considerable quantity of salt, which sells at the works, at one dollar per bushel. King's wells have produced on a lease of five years, an annual rent of $60,000, or $300,000 for the term of five years. Preston's works have been rendered much less valuable by being diluted with fresh water, caused by a spring of fresh water flowing in the midst of the salt.

Kentucky furnishes numerous salt works. On the Big and Little Sandy rivers are salt works in operation; they afford, however, a weak brine, and are on the decline, in consequence of the reduced price of salt, which sells at fifty cents per bushel. Green river furnishes numerous salt works, which are very productive: these works are all flourishing, and under favorable prospects of increasing. They are the most extensive in the state: the price of salt at the works is fifty cents per bushel. On Goose creek, also, a tributary to the Kentucky river, are very extensive works; these, and the springs on Green river, might support works affording inexhaustible quantities of salt; the price at the works is fifty cents per bushel.

In Ohio many salt works exist; they are, however, on the decline, in consequence of the reduced price of salt. The principal ones now in operation are on the Sciota, Muskingum, and Yellow creek; the price of salt at these works is fifty cents per bushel.

In Illinois, on Saline river, near Shawneetown, are extensive salt works, formerly owned by the United States: they are now the property of the state. The price of salt at the works is fifty cents per bushel.

In Virginia, on the Great Kanawha, are very extensive salt works. The quantity furnished is about one million bushels* per annum, and may be increased to almost any

* It is stated in the last edition of Professor Cleaveland's Mineralogy, that the whole amount of salt obtained in the United States, is one million bushels per annum. This must be very far short of the present annual product, as the Kanawha works alone furnish this amount.

amount. The brine at the Kanawha works, as appears from careful experiments made by Dr. Putney, is very strong,—sixty-five to seventy gallons yielding one bushel of salt. The price at the works is from twenty to twenty-five cents per bushel, according to the quantity purchased. It is obtained by boring to a depth of from three to five hundred feet. Large quantities of inflammable gas are sometimes disengaged, with considerable noise and violence, preventing operations for several days. The salt works at Kanawha, and those on the Holston near Abingdon, are the only two in Virginia worked to any extent. These works, and those of the Kiskiminicus, one of the waters of the Alleghany river, furnish the principal part of that used in the western states.

Pennsylvania. On the Kiskiminicus, near Pittsburg, are the most extensive works in the state. The price of salt at the works is from twenty to twenty-five cents per bushel. There are several other works in the neighbourhood of Pittsburg; they are, however, all comparatively small. The brine of the Kanawha and Pittsburg works is evaporated by coal: all the other works in the United States employ wood, which operates in diminishing the profits by increasing the expenses every year. This, with many other causes, produces the suspension of operation in many salt works, particularly in places where a competition exists, and some of the competitors enjoy the above named advantages. Hence it is, that although the price of salt at Kanawha and Kiskiminicus is only from twenty to twenty-five cents, the manufacture is conducted with profit, whilst other establishments, where salt brings fifty cents and upwards, are rapidly declining, in consequence of the reduction of price, which formerly was one dollar to one dollar and twenty-five cents per bushel. Their brine being weak, and laboring under other disadvantages, they cannot afford to work the springs for salt at that price, and the manufacture is consequently on the decline.

There are numerous salt springs in the state of New-York, some of which are very productive. The best springs are near the canal which connects the Hudson with Lake Erie. The salt is obtained by the spontaneous evaporation of the brine exposed in vats to the influence of the sun, aided by steam conducted through tubes immersed in the brine.

There are also salt works in Alabama. Being recently discovered, they are at present of moderate extent. They will no doubt be extended and enlarged in a short time.

Considerable quantities of salt are obtained in North Carolina from a neck of the sea, by digging pits near the shore, which are filled by the tide; it is then carried by trenches to a distance, where it is evaporated by the sun; and being situated near extensive fisheries, is employed to great advantage and profit in putting up fish for exportation.*

Nearly all the salt furnished in the United States is obtained by boring, and the brine is evaporated by heat; the mother water, or bittern, as it is termed, is thrown away. It is a strong solution of muriate of lime, and magnesia. As this article is produced in considerable quantities, Epsom salt and magnesia might be advantageously manufactured from it. It is stated that the bittern has proved very deleterious to animals; horses, cows, &c. have been killed by taking small portions of it, which frequently happens, as it forms on evaporation, incrustations which are mistaken for salt.

Art. II.—*Notice of the Salt Springs and Manufacture of Salt at Salina, Syracuse, &c. N. Y. made at the request of the Editor; by* Stephen Smith, Superintendent at Salina.

In the town of Salina, and state of New-York, nearly equidistant from Albany on the river Hudson, and Buffalo at the north-eastern extremity of Lake Erie, are situated the works, the most extensive in the United States, for the manufacture of salt from natural brine. The indications of that substance along the margin of Onondaga lake, were similar, as is be-

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* The following method is adopted for extracting salt from sea water by spontaneous evaporation in hot climates: Several parcels of flat ground, under the mark of the high tides, and properly surrounded by dikes, are disposed near the sea, into many compartments, the last of which are well lined with clay, and properly beaten in an even horizontal surface; so that when the sea water is allowed to run into these, after it has partly evaporated in the former ones, the heat of the sun, in a few hours, evaporates it enough to crystalize the salt, which falls to the bottom, and is drawn out with a flat piece of board at the end of a pole, &c.

But in cold climates, much labor and fuel may be spared by letting the sea water stand to freeze, and after separating the ice, which is formed only of the watery particles, the remaining brine contains a much larger quantity of salt, which may be very soon evaporated by fire. This method is stated by General Baur to have been practised with great success in Russia, and perhaps is also now used in various other parts of the north.—*Cronstedt, Vol. I. p.* 360.

lieved, to those found at the salt licks so common in the interior of this country; and the knowledge of their existence was derived, by the travellers or white settlers who first visited this region, from the aborigines, to whom, we may presume, they must have been known for ages anterior to the discovery of the American continent by Columbus.

One of the earliest settlers in the county of Onondaga has informed the writer that, to procure salt for his family, about forty years since, he, with an Indian guide in a canoe, descended a small river, that discharges into the lake at its southeastern termination, along the shore of which he passed a short distance to the right, and, ascending a rivulet (now Mud creek) a few rods, arrived at the spring or natural discharge of salt water, which was obtained by lowering to the bottom, then four or five feet beneath the surface of the fresh water of the lake, an iron vessel, which, filling instantly with the heavier fluid, was drawn up, and the brine poured out. In this way, he got enough to make on the spot, by boiling, and without any separation of the earthy impurities that were held with the salt in solution, a small quantity of brownish colored and very impure salt. Since that time other springs have been discovered, at various and almost opposite points on the shores of the lake, and many wells have been sunk to procure brine for the manufactories at the villages of Liverpool, Salina, Syracuse, and Geddesburgh. The wells did not exceed eighteen feet in depth, and in the strength of the water which they respectively afforded there was great difference, which varied very much with the seasons, with this remarkable circumstance, that it sometimes diminished fifteen to twenty per cent., and in some instances one-third, as the adjoining lands, on the advance of summer, became drained; and the lake, which in the spring overflowed the wells, had subsided six or eight feet.

Until the close of the summer of 1822, the salt water had been pumped principally by men, who were then superseded by hydraulic machinery, capable of elevating to a height of seventy feet between fifteen and twenty thousand gallons per hour. Its operation produced a more rapid influx of the brine, with an increase of strength from twenty to twenty-five per cent., standing at 13° on the hydrometer of Beaumé, of which the point of saturation was 22°, and has continued at that degree, with very little change, to the present time.

In the course of the last eight years, a manufacturer at Salina, under a law of the state for the encouragement of the undertaking, has made several unsuccessful attempts, by boring in different places, to discover rock salt: and, within eighteen months, the same operation has been performed, with partial success, to obtain brine of increased strength and quantity. At one place, in Syracuse, the boring was two hundred and fifty feet, eighty feet lower than the deepest places in Onondaga lake, and principally through indurated clay, but the adventurers, meeting with very hard rock, supposed to be granite, the work was discontinued without the discovery of any vein of salt or even fresh water. At another place, salt water of inferior strength appeared at the commencement, but at the depth of fifty feet the boring was abandoned, owing to the difficulty of forcing down the tube, of sheet iron, through a bed of rounded smooth stones, which were of every size from common coarse gravel to that of a man's head, and of a variety of colors and texture.

About a mile from the south end of the lake, and on the border of Onondaga creek, (the small river before mentioned,) among stones resembling those just described, a well had been sunk thirty feet, and the work suspended three years; but last summer a tube was driven down, in the centre of the well, fifty feet further, into a stratum, the thickness of which is undetermined, of clean washed gravel: ten feet from the surface of the ground the saltness of the water was first perceptible, increasing with the descent of the well, and afterwards of the tube, till the boring ceased at the depth of eighty feet, where it was found to contain twenty-two ounces of salt and impurities in the gallon. When the water of the well is lowered eight feet by pumping, the quantity discharged from the tube, which has the upper part cut off at that depth, is one hundred gallons per minute, and, when the pumps are stopped, it rises to the surface of the earth and discharges in a small stream.

At Geddesburgh and Green Point, places on opposite shores of the lake, there has been boring to considerable depths, not over eighty feet, and other veins have been opened of salt water which is extensively used at the former place and Liverpool.

Three large metallic pumps, moved by the surplus water of the Erie canal, and one, worked by a small steam engine, raise the brine from the wells to the reservoirs, from which it is conveyed, by means of wooden pipes, to every manufactory.

A great number of plans and experiments, *called improvements*, have been or are still in operation, but the works erected for the making of salt, and now principally used, are denominated Blocks, Solar Works, and Steam Works.

The Blocks, constructed with potash kettles, containing from eighty to one hundred and twenty gallons each, are of the greatest extent,—the kettles are placed in masonry, in two parallel lines, having from eight to twenty in each line, (of course from sixteen to forty in a block,) under which there are separate passages for the heat with fire places or *arches* at one end, and a flue or chimney, common to both, at the other end of the block. The fuel is exclusively wood, of the kinds most common in the forests of this part of the country, such as beach, maple, elm, hemlock, bass wood, &c. of which the prices, for the last six years, have been from seventy-five cents to one dollar and fifty cents per cord, delivered at the works.

In the boiling down of the water to saturation, a portion of the impurities, sulphate and carbonate of lime stained with iron, is deposited in ladles and taken out, and the *vaporization* of the brine is continued until but a small quantity remains; when the salt which has been made, and which is, even at first, beautifully white and of fine grain, is taken out into baskets, drained, and removed; and the kettles are again filled with salt water, and the operation repeated. The inner surface of the kettles soon becomes firmly incrusted with a compound of the earthy substances and salt, which require frequent removal to prevent injury from overheating and cracking the metal.

Next in extent, or more properly in production, are the erections adjoining the Erie canal for evaporation by solar heat: they are vats of wood, resting horizontally upon a great number of small posts driven into the ground, according to the inequalities of the surface over which they are built, touching it in some places, and at a height of ten feet in others; but the most convenient height is between eighteen and thirty-six inches from the ground. Their width is eighteen and a half feet, depth from six to fifteen inches, and length from eighty to six hundred and forty feet; and they have roofs in divisions of sixteen feet each, sustained by rollers which travel on level supporters, and are moved on and off by the strength of one man. The water from the reservoirs is received first into the deepest vats, in which is deposited much of the iron or coloring matter, which appears in the form of a pellicle as soon as the temperature (at the wells it is 50°) is increased by the action of the sun or warm atmosphere. From those it is passed by means of pipes into vats of less depth, not exceeding six inches, and at a lower level, in which it remains till, by the evaporation and consequent concentration of the brine, and the precipitation of sulphate and carbonate of lime, it is sufficiently depurated for the crystalization of the salt which will then begin to appear on the surface. The brine, leaving behind the substances that have been separated, is again drawn off into vats of a level still lower, which are kept clean, and in which the salt is made with greater or less rapidity, according to the altitude of the sun, the clearness of the atmosphere from clouds and moisture, and the strength of the wind. As the brine, by the formation of the salt in the last vats, diminishes, and as it is necessary that it be preserved of a proper depth, which seldom exceeds five inches, and should always cover the salt at the bottom, further supplies are drawn occasionally, and as they are needed, from the second gradation or tier.

The removal of the salt from the vats is without any regularity as to time or quantity, and is dependant upon the convenience of the manufacturer, who sometimes leaves it till there is an accumulation of three or four inches, or takes it out when there is barely enough to cover the bottom. It is shovelled into tubs, holding about one hundred pounds, in which it is drained for a few minutes, and, without further drying, is conveyed in carts to the storehouses.

The measured bushel will weigh from seventy-four to eighty-five pounds—the product of the slowest evaporation being the heaviest. When the weather has been clear and calm, and the salt water free from agitation, the surface has often been heated to 106°, while that in contact with or near the bottom of the vat was 122°, and, by the hydrometer, was ascertained to be specifically lighter than the upper portions.

The mother-water (remaining after the extraction of the salt) is a solution of the muriates of lime and magnesia, possessing a pungent taste, unlike the bitter in that from the ocean, and probably containing very little magnesia.*

* According to my experiments, there is, in that which I examined scarcely a trace of magnesia. See also Mr. Chilton's results, Vol. VII. p. 344, of this Journal.—Ed.

It is estimated that the solar establishments at Syracuse, including the land necessary for the roofs and passages, occupy one hundred and ten acres; that the aggregate length of the vats is thirteen miles, and their superficial surface one million two hundred and fifty thousand square feet, of which the annual product is about three thousand five hundred tons.

The steam-works are similar in their construction to the blocks, the kettles of which are covered, to save the steam produced in the boiling of the water to saturation, and, by condensation in its passage through metallic pipes, immersed in the brine which is in deep wooden vats, the heat is applied a second time to the crystallizing of the salt.

Some of the earliest laws for the regulation of the manufacture were passed by the state of New-York in 1797, anterior to which year the business was in its commencement, but has since been gradually extending; and last year, in the town of Salina, the quantity made was about thirty thousand tons, one million two hundred thousand bushels, of which the average price at the works, exclusive of the state duty, was twelve and a half cents per bushel of fifty-six pounds. It is commonly packed, for sale, in barrels that contain five bushels, and is inspected and branded before it can be removed.

"An account of the Salt Springs at Salina, by Lewis C. Beck, M. D." published in the "New-York Medical and Physical Journal, No. 18," contains analyses of the brine, salt, and impurities, with geological and other information.

In regard to the saltness of the water at the bottom of Onondaga lake, (very commonly called *Salt* lake,) it is apprehended that Dr. B. was misinformed, as an experiment with a bottle, let down in the way that he mentions, in the deepest places, about one hundred and fifty feet, brought up cold fresh water only. The following is his analysis of the brine, in which there is an omission of the iron, which evidently exists in the salt water of every spring yet discovered in this vicinity.

Carbonate of lime, - -	1.79
Sulphate of do. - -	4.20
Muriate of do. - -	3.48
Muriate of magnesia, - -	2.57
Muriate of soda, - -	143.50
	155.54

The weight of the dry residuum from a like quantity of water was 156.

Water has been repeatedly taken from the different wells, as it flowed in from the earth, and where it could not possibly have been in contact with the iron of any part of the pumping machinery, and, on scraping into it some nutgall, with a piece of broken glass, there has been observed, in a short time, a change from limpid transparency to a purple color, which soon became green, and finally of a reddish brown; and, after standing two or three weeks, there was a dark brown deposit that covered the bottoms of the tumblers in which the experiments were made.

Bubbles of carbonic acid are continually escaping, and frequently in great quantity, from the brine of the springs.

As one of the plants that frequent salt marshes on the sea shore was observed growing abundantly at Salina, Mr. Smith was requested to examine it for iodine—which substance did not appear on the addition of sulphuric acid and solution of starch to the fluid bittern, or the solid residuum which it afforded by evaporation. The following is Mr. Smith's remark in a P. S. to his communication.—Ed.

I have made, and repeated, the experiment requested by you, when here, with the samphire, of which the quantity employed yielded half a peck of ashes. The product was principally muriate of soda, without any appearance of iodine.

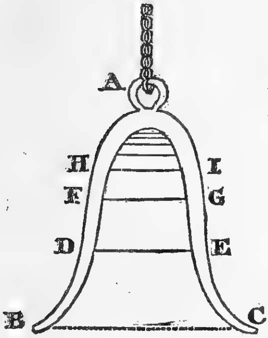
Art. III.—*Hypothesis on Volcanos and Earthquakes; by* Joseph Du Commun, *of the Military Academy at West-Point.*

The air of the atmosphere at the surface of the earth, will support, in barometer tubes, mercury at 30 inches,
fresh water at 33 feet,
and sea water at about 32 feet.

It is eight hundred and twenty-eight times lighter than fresh water, or - - - - - : : 0,00120 : 1.

And because fresh water is to sea water as 1000 is to 1029, so air is eight hundred and fifty-three times lighter than sea water, or - - - - - - : : 0,00118 : 1.

But for reasons to be explained in the course of this article, we will assume that the air is only eight hundred times lighter than sea water, or - - - : : 0,00125 : 1.



This being granted: let us suppose that a bell A B C, suspended by a metallic chain, and full of atmospheric air, is plunged into the ocean; the air contained in it will be compressed more and more as it descends, and consequently its density will be increased in proportion to the depth it penetrates. This condensation is here represented, at first by the line BC, at the moment of its immersion, then by the lines DE, FG, HI, &c.

The following table will show the ratio of the condensation compared with the depth of the immersion.

Goemetrical ratio of the compression represented by the number of Atmospheres.	Weight of the Atmosphere equal to 32 feet of sea water.	Immersion of the Bell in the sea expressed in feet.	Total pressure of the air in the bell expressed in feet of sea water.	Increasing density of the air in the bell compared with unity as the density of sea water.
1	32	0	32	0,00125
2	32	32	64	0,00250
4	32	96	128	0,00500
8	32	224	256	0,01000
16	32	480	512	0,02000
32	32	992	1,024	0,04000
64	32	2,016	2,048	0,08000
128	32	4,064	4,096	0,16000
256	32	8,160	8,192	0,32000
512	32	16,352	16,384	0,64000
1024	32	32,736	32,768	1,28000

From this table it appears that the point at which the density of the atmospheric air would be exactly equal to 1, or equal to the density of sea water, is to be found between 16,352 and 32,736 feet immersion in the sea. And if we wish to determine by calculation the depth at which that precise point is obtained, we shall find twenty-five thousand six hundred feet, or about four miles and seven-eighths, equal to the pressure of eight hundred atmospheres.

Thence it follows, that at the depth of four miles and seven-eighths the air would be compressed in the bell to the same density with the sea water.

But now, when arrived at this point, if we plunge the bell more and more into the sea, the density will still increase, and will soon exceed that of the surrounding water; at that moment what will become of the bubble of air contained in the bell, if even we suppose it to be upset?

Will it come up and break at the surface? It cannot, for by the supposition, it is heavier than its own volume of water; on the contrary, it must descend to the bottom, with an increased velocity; for its density will increase as it sinks, and it must remain at the bottom of the sea, just as a stone itself would do.

I request the reader to stop here, and reflect one moment; the novelty of the assertion, that a bubble of air is precipitated to the bottom of the sea, instead of rising to its surface, merits to be examined with attention before it is admitted; if it can be destroyed, either by argument or experiment, the remainder of this article becomes useless, for all that follows is in the form of corollaries from this first principle; but if, after a close and severe examination, the reader, as well as myself, is convinced of its truth, let us then proceed together.

If a series of bells, similar to the one just described, were constantly in operation through the whole extent of the ocean, there would soon be, under the water of the sea, a layer of compressed air of its whole extent. But has nature provided for such an apparatus? Yes, she has, with the simplicity, ease, grandeur, and efficacy that she shows in all her operations; let us merely study her laws, and we shall soon discover it.

Let us take a glass of water from a running spring; let us expose it for some time to the light and heat of the sun; we shall soon observe bubbles rising from every part of the water, collecting at the surface, and breaking the one after the other. Let us put some of the same water into a convenient vessel by the fire, and we shall again observe a rising of bubbles before the moment of ebullition; and, still better, let us put some of it into a glass under the receiver of an air-pump, and produce a vacuum, when the bubbles will rise with great celerity; let us collect the air thus disengaged, and we shall find its quantity a little above four per cent. in bulk of the water under experiment.

The water of the sea, always under full atmospheric pressure, is constantly agitated by the wind, and, being divided, at its surface into waves and breakers, it so multiplies its points of contact with the atmospheric air, that it, of course, absorbs all that its affinity for it, under these circumstances, allows. Moreover, all rain water being divided into drops, the most favorable condition for its combination, brings down water perfectly saturated with air, and the whole quantity of rain that falls on the globe goes ultimately to the sea, whether it falls directly into it, or whether it is carried to it by rivers flowing down and renewing constantly their surfaces, all which circumstances unite to supply the sea with a new and perpetual addition of combined atmospheric air; it may then be admitted that the sea water is completely saturated with this fluid.

We have seen, in one of the preceding paragraphs, that the affinity of the air for water is very weak. Is it a chemical combination, or merely an affinity of cohesion? It matters not which opinion we form in that respect, for true it is, that the least change in the temperature, or in the relative densities, destroys their union. We have just seen that in spring water, by the mere subtraction of the atmospheric pressure, the air resumes its gaseous form, and then, from its relative levity, separates from the water, and ascends and breaks into bubbles at its surface. Now, below the depth of twenty-five thousand six hundred feet, the air is denser than the water; and if a density different from that of the water in *minus* has been sufficient to operate their disunion, a similar difference in *plus* must produce the same effect. A bubble of air, under the pressure of eight hundred atmospheres, small as we may conceive it, is still a bubble of air, and its density being superior to that of the medium in which it is placed, it must plunge to the bottom, performing exactly what we have ascertained to be the case with the bell. I conceive that these bubbles collect together in sinking, just as they do in rising, making a constant shower at the bottom of the sea, to supply the constant consumption of it, as we shall soon have occasion to state.

Until this moment we have called the air absorbed by water atmospheric air; which, according to the multiplied experiments made on it, appears to be a compound of 24 oxygen, 75 azote, and 1 carbonic acid gas; total 100. Whereas, the air absorbed by water, although a compound of the three same gases, contains them in different proportions. The analysis of the air contained in spring water has been made at different times, in different places, and by different persons, and, consequently, the results are all different and uncertain. The analysis of the air contained in rain water, river water, and particularly sea water, should be the object of our immediate researches, as going more directly to our purpose; but I could not find any publication on this subject. To arrive at any positive result would require no small trouble, and meet with many difficulties, as the analysis should be performed at sea, in different latitudes, and upon water taken at various depths. It is probable, however, from what information we can collect, that the relative proportion of the three gases is altered; that the absorbed air contains more carbonic acid, less azote, and the same relative quantity of oxygen, which alteration must increase its density. These considerations have induced us, in the foregoing table, to represent the density of the air and water by the numbers 800 and 1, instead of 853 and 1. This is the explanation we have promised to give.

The depth of the sea water is not a variable, it is an absolute quantity; a measure which will be determined to a foot by calculation as soon as we have exactly the relation of the three gases it contains. By our computation, which is, however, not far from the truth, we found it twenty-five thousand six hundred feet, or four miles and seven-eighths; but whatever be the depth, at the point of contact, the air must be exactly of the same density with the water. It cannot be more or less; for, if it were less, it would rise to the surface; if it were more, a new quantity of it would shower again through the water.

Air compressed under such an immense weight must have a tremendous force of elasticity. It is superior to any thing we have as yet produced in our most powerful engines, not excepting Perkins' high pressure steam artillery; so that, if we conceive a tube of sufficient length and resistance to open a communication through the sea between that immense reservoir of compressed air and our atmosphere, the projectiles placed in this tube would acquire a velocity several times greater than that of a cannon ball; this air then must penetrate, under ground at four miles and seven-eighths below the surface of the earth, through the crevices of the rocks, and in all the subterranean vacuities which communicate with each other, or with the general reservoir of air. And if it meets there, or rather, when it meets there combustible substances, as bitumen, sulphur, coal, &c. a conflagration must ensue, which is constantly supplied with a new quantity of blowing air, forced by the pressure of the sea, as if by a permanent forge bellows. The air, after having supported combustion, rarefied by the heat, opens its way, and issues by apertures at the summit of volcanic mountains, which we have called craters, as it does in common chimnies at the top of the flues. Such is our conception of these subterranean fires called volcanoes, considered in their quiet and peaceful operation.

It would be difficult to conceive how combustion should be constantly supported under ground without a constant supply of air; and we do not perceive how that air would be brought into those subterranean cavities, except by the means just suggested; we see no hole or opening which might be considered as a draught for the passage of air; on the contrary, all the apertures observed emit gases that may be considered as the result of the conflagration of combustible bodies, and decomposition of water by fire. We see smoke ascending from the top of volcanic mountains, and all these phenomena seem to speak in favour of our hypothesis.

We do not think it necessary to enlarge on the various products of these subterranean fires; a great deal has been said and published on this subject; the formation of carbonic acid; its emission in its natural gaseous state; its combination with lime, magnesia, metallic oxides, &c.; its abundance in mineral waters; the flowing of hot water springs, either simple or sulphurous; the rushing out of hydrogen gas, sulphuretted or carburetted: these results are the natural effects of these permanent fires, considered in their quiet state.

Now, it is time to present our readers with the complement of the theory by the spectacle of an eruption. A large volcano may be considered as a whole coalery on fire, several miles and perhaps several hundred miles in extent, five miles under ground, that is to say, under the inferior level of the sea water; coals, bitumen, sulphur, &c. are constantly burning; minerals, sand, and stones are melting, vitrifying, and running at the bottom of the cavern in the shape of lava, of which it forms a permanent lake in fusion, just as melted iron is collected at the bottom of a casting furnace. These things being in this situation, if a sudden vacuum is produced, what will happen? But I may be stopped here, and be asked, how can a sudden vacuum be produced? I see many causes why it may, but the most simple and natural, and consequently the least objectionable one, is, that after a certain time, a number of years that cannot be foreseen, for it is not periodical, a layer of the coal being burnt, reduced to ashes, the mineral to lava, the ground above, no longer supported, crumbles down, with a rumbling noise; a new surface of cold ground is put in contact with the overheated air and vapours, and a sudden condensation is produced; a partial vacuum follows: it is so sudden, that it communicates a tremor to the surrounding ground, which is felt as the first shock of an earthquake. This vacuum produces in its turn a violent aspiration, that brings down the water of the sea itself, and of all the streams that may communicate with that furnace. Then, a reverse effect is produced; water coming in contact with the melted lava and the burning coals, is acted upon in two different ways; a part is vaporised, and another part decomposed; steam and hydrogen gas are produced in immense abundance; these fluids must open their passage; water is repulsed back into the sea, which rises above its natural level, under the appearance of a huge tide or wave; another part may be thrown off through the gaping ground, and even may issue mixed with the flames of the mountains. In the meanwhile, new shocks are felt, until the weakest point has yielded to the combined powers of the steam and gases, actuated by the heat and a pressure of eight hundred atmospheres. Generally, the former crater, filled in part with loose stones, lava, and ashes of the preceding eruption, is the weakest point; all is thrown up; a column of fire, produced by the burning hydrogen, is raised to the clouds; ashes, the result perhaps of twenty years' combustion, in sufficient quantity to bury villages and cities, and stones of all sizes, loosened, are projected to an immense distance; and, finally, the lava, swept away by the steam, gases, and blowing air, is raised up to the summit of the crater, or runs on one side of the mountain, after having broken open a passage by its enormous mass and weight. When the steam and gases are exhausted, when the lava has flowed out for some time, the eruption decreases, and finally is stopped, because the column of lava in the crater, being of a density superior to the water of the sea, chokes the passage, and the volcano must then resume its quiet operation.

But, why should I endeavour to describe what *must* happen? Let us rather ascertain what *has* happened, and see whether the facts recorded agree with the theory here presented.

One of the first historians who gives an account of Vesuvius, is, I believe, Pliny the younger. We read in his Epist. xx. lib. vi. these remarkable words:

"Preterea mare in se resorberi et tremore terræ quasi repelli videbamus. Certè processerat littus, multa animalia maris siccis arenis detinebat. Ab altero latere nubes atra et horrenda ignei spiritûs tortis vibratisque discursibus rupta, in longas flammarum figuras dehiscebat; fulgoribus illæ et similes et majores erant."

The retreat of the sea, and its sudden return by the effect of the elasticity of the fluids, seems to be one of the best ascertained facts.

Eruption of Vesuvius, 1730, *by Nicholas Cyrillus, Phil. Trans. vol.* 37.

"March 8th. Vesuvius sends forth a great smoke and stream of fire, with hollow rumbling. 9th. The following night Vesuvius thundered as it were twice. 10th, 11th, 12th. The clouds hide the smoke and fire. 13th. Smoke lessened. 14th. In the evening, after eight o'clock, the fire arose to a vast height...... Pumice stones, red hot, of two or more ounces weight, were driven several miles like a shower of hail."

The blazing flame, hollow rumbling, throwing up of smoke, ashes, and stone, are but the natural results already anticipated.

Collection of various papers concerning Earthquakes felt in England in 1750. *Phil. Trans. vol.* 46.

"The mighty concussion was felt precisely at the same instant of time, being about half an hour after twelve at noon. Let us reflect on the vast extent of this trembling, one hundred miles in length, and forty in breadth, which amount to four thousand square miles in surface. That this should be put into such an agitation in one moment, is such a prodigy, as we would never believe, did we not know it to be a fact, from our own senses."

The astonishment of the writer of this paragraph would have ceased, if he had conceived, as ourselves, that the vacuum produced in a receiver is almost instantaneous in all its parts, whatever be its extent, or is filled as instantaneously, because steam and gases rush into a vacuum at the rate of thirteen hundred and five feet in a second of time, under the pressure of one atmosphere: what then must it be under eight hundred? The following extracts will come again in support of this assertion.

Account of an Earthquake at Lisbon, Nov. 1st, 1755. *Dr. Wolfal. Phil. Tr. vol.* 49.

"Soon after the shock, (forty minutes past nine,) which was near high water, the tide rose forty feet higher, in an instant, than was ever known, and as suddenly subsided."

The same at Oporto, in Portugal, Nov. 1st, 1755. *Phil. Tr. vol.* 49.

"It began about half an hour past nine....and soon saw the river in some places open, and throw out a vast deal of wind, which was very terrifying......"

The same at Cadiz, Nov. 1st, 1755. *Benjamin Bewick. Phil. Tr. vol.* 49.

"Just before ten, the whole town was shaken with a violent earthquake......they saw rolling towards the city a tide of the sea, which passed over the parapet of sixty feet above the ordinary level of the water......the waves came in this manner four or five times, but with less force each time."

The same in Barbary, Nov. 1st, 1755. *General Fowke, Governor of Gibraltar. Phil. Tr. vol.* 49.

At Tetuan, "the earthquake began at ten in the morning...."

At Tangier, "it began about the same time......the sea came up to the very walls, a thing never seen before, and went down with the same rapidity. These commotions of the sea were repeated eighteen times, though not with the same violence as at the first time......The fountains were dried up, so that there was no water to be had till night."

At Arzila, "it happened about the same time."

The same in the Island of Madeira, Nov. 1st, 1755. *Dr. Thomas Heberden. Phil. Tr. vol.* 49.

"At half an hour past nine o'clock in the morning was felt a shock of an earthquake......In the northern part of the island, the inundation has been more violent; the sea there retiring at first above one hundred paces, and suddenly returning overflowed the shore......"

The same at Neufchatel, in Switzerland, Nov. 1st, 1755. *Mr. Pantrovers.*

"The dreadful earthquake has been perceived even in this country; it swelled our lake to the height of near two feet above its natural level......"

The same at Lyons, in France, Nov. 1st, 1755. *Mr. Trembley. Phil. Tr. vol.* 49.

"It is said that the waters retired for some moments at the end of the lake of Geneva, and that a motion was observed in those of the lake of Zurich......"

Agitation of the Waters. Nov. 1st, 1755. *John Pringle. Phil. Tr. vol.* 49.

"About ten o'clock of the forenoon, at a seaport on the Frith of Forth, about seven miles higher up than Leith, the water was observed to rise very suddenly, and return again with the same motion; and this continued for three or four minutes, it being then calm; but after the second and third rush of water, it was always less."

We have expatiated with some details upon the dreadful earthquake which was so fatal to Lisbon in 1755, destroyed whole cities in Europe and in Africa, cost the lives perhaps of one hundred thousand human beings, and was felt upon a surface of more than one million square miles at the same moment. We have taken into consideration particularly its effects upon the water of the sea. The detonation took place under ground, or rather under the sea, in that space which we suppose filled with condensed air, below its inferior level. If we should wish to locate precisely the centre of concussion, judging from its intensity and direction, it seems to be, between the Azores, Madeira, and the continent. The sea was swelled at the same moment from the thirtieth degree of latitude to the fiftieth, that is to say, on the coast of Africa from Morocco up to Tangier, on the coasts of Spain and

Portugal, France, Hamburg, the coast of England, and even to the north of Scotland. However, a fact observed by Captain Affleck, of the Advice man-of-war, then at Antigua, and recorded in the Philoso. Transactions, vol. 49, surpasses in wonder even all this:

"On the first of November last, you had a remarkable flux and reflux of the sea at Portsmouth, and other parts of the coast, which was agitated in like manner, AT THE SAME TIME, on the coast of America, and all these islands."

If by the words "same time" is meant the same hour, it is in fact three hours later, on account of the difference of longitude, and the distance between the point of explosion across the Atlantic to the Antilles, being about four thousand miles, and will give a velocity of two thousand and forty feet in a second of time. This velocity cannot be that of a wave of water; it must be, it can be, but a velocity of percussion in an elastic fluid or gas of a greater density than atmospheric air. This fact, and similar ones, will enable us one day to give not only a mathematical demonstration of the existence of such a fluid under the sea, but also to calculate exactly its density.

Let us proceed in our investigation.

Earthquake in Calabria, 1638.

In Goldsmith's History of the Earth, is an account of that great convulsion of nature, translated from the celebrated Father Kircher, from which we extract the two following observations:

"The Gulph of Charybdis, which we approached, seemed whirled round in such a manner as to form a vast hollow, verging to a point in the centre."

And afterwards:

"The sea itself seemed to wear a very unusual appearance. Those who have seen a lake in a violent shower of rain, covered all over with bubbles, will conceive some idea of its agitation; my surprise was still increased by the calmness and serenity of the weather; not a breeze, not a cloud......"

The rushing of the sea into a subterranean abyss cannot be better demonstrated than by the first observation, and the ejection of gases through its water, than by the second.

Earthquake in Sicily, 1692. *Schenchzer. Phil. Tr. vol.* 33.

"Just at the time of the second shock, the sea retired from the land, all along the coast, leaving its bottom dry for a considerable distance, and in a few minutes it returned again with great fury, and overflowed the shores. In many places the earth gaped prodigiously......Out of all these openings sprung forth a great quantity of water, which drowned the neighbouring places. This last (shake) was stupendous beyond imagination, the fiery eruption of the burning Ætna throwing out a prodigious quantity of flames, stones and ashes, &c."

Earthquakes in the two Calabrias, Messina, &c. 1783. *By Sir Wm. Hamilton. Phil. Tr. vol.* 73.

"A shock had raised and agitated the sea so violently, that the wave went furiously three miles inland, and swept off in its return two thousand four hundred and seventy-three of the inhabitants of Scilla, &c.

"At the moment of the earthquake the river disappeared, and returning soon after, overflowed, &c.

"The officer who commanded in the citadel (Messina) assured me that on the fifth of February, and the three following days, the sea, about a quarter of a mile from that fortress, rose and boiled with a most horrid noise, &c."

The same. 1783. *Count Francesco Ippolito. From the Italian.*

"Flames were seen to issue from the ground, &c.

"Out of many of these apertures a great quantity of water spouted during several hours; from one of them, about a mile from the sea, there came out a large quantity of salt water. Warm water likewise issued from the apertures made in the plain, &c."

Molucca Islands. 1693. *In a letter to Nicholas Wetsen, of Amsterdam. Phil. Tr. vol.* 19.

"The mountain (———) has cast out so many stone, and some near six feet long, that the adjacent sea, which has been forty or fifty fathoms deep, is not only filled up there, but become many fathoms higher than the water."

Eruption of Mount Vesuvius, June 12th, 1794. *Sir William Hamilton. Phil. Tr. vol.* —.

"The classical accounts of the eruption of Vesuvius, which destroyed Herculaneum and Pompei, and many of the existing printed accounts of its great eruption in 1631, might pass for an account of the late eruption, by only changing the date, and omitting the circumstance of the retreat of the sea from the shore, which happened in both those great eruptions, and not in this, &c."

The water of the sea not retiring from the coast in this eruption seems to be an anomaly. Whether the suction or aspiration was performed too slowly, or too far from the shore to be observed, or whether it did not take place at all from the sea, still we are in no apprehension of seeing an eruption without the presence of water; for, in the same relation, a few lines lower, we read:

"The water at the great fountain at Torre del Greco began to decrease some days before the eruption......It was necessary in all the other wells of the town and its neighbourhood to lengthen the ropes daily to reach the water, and some of the wells became quite dry......"

"Subterranean noises were heard at Resina for two days before the eruption. Soon after the beginning of it, ashes fell thick at the foot of the mountain....and though there were not at that time any clouds in the air, the ashes were wet, accompanied with large drops of water, which were to the taste very salt......

"After some time, the lava ran in abundance, freely and with great velocity......The frequent falling of the huge stones and scoriæ, which were thrown up to an incredible height, from some of the new mouths, one of which, having been since measured, was ten feet high, and thirty-five in circumference, &c.

"It is impossible that any description can give an idea of this fiery scene, or of the horrid noises that attended this great operation of nature. It was a mixture of the loudest thunder with incessant reports, like those from a numerous heavy artillery, accompanied by a continual hollow murmur, like that of the roaring of the ocean during a violent storm; and, added to these, was another blowing noise, which brought to my mind that noise which is produced by the action of enormous bellows at the furnace of the Carron iron foundery in Scotland, and which it perfectly resembled, &c."

If this last paragraph had been written with the direct intention of supporting our theory, could Sir Wm. Hamilton have made use of other expressions?

We will here recapitulate in a few words the whole of the hypothesis. We have endeavored to establish—that the surface of the earth, as deep as four miles and seven-eighths, is the domain of water; that it cannot penetrate deeper, as it there meets with a fluid denser than itself; that either in the open sea, or between the crevices of the rocks and ground at that depth, is its inferior level; that at the surface of the earth, fresh water ascends higher than the superior level of the sea, in proportion to its relative levity, and the depth at which they come in contact. This is what we have particularly tried to demonstrate in a former communication, (vol. xiv. p. 174); that below four miles and seven-eighths is condensed air which supports the combustion of inflammable bodies, and keeps in activity those subterranean fires, the immediate cause of earthquakes and volcanos; that it ceases to be problematical how these fires under ground are not smothered for want of oxygen, and how those under the sea are not extinguished by its water; that we now may account for volcanic islands suddenly rising or disappearing; that it also explains why earthquakes, without any outward explosion, extend to a greater distance, and are more destructive, than those breaking out in a volcanic eruption, &c. &c.

But it is high time to close this article, not because the subject is exhausted, for it seems to extend in proportion as we proceed, but because the limits granted to a publication are perhaps already outreached. We will hereafter present our readers with some new considerations derived from the same principle.

JOSEPH DU COMMUN.

West Point, April 16th, 1828.

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*Objections to the above Theory.**

1st. The experiments of Perkins† prove that air, and those of Mr. Faraday,‡ that many gases, and from analogy, (grounded on so many established cases,) we may infer that *all* gases, under extreme compression, especially when aided by cold, lose their elastic form, and become fluid.

2d. This being the fact, all reasonings respecting the condition of air under extreme pressure, must contemplate it as a fluid—(truly such while the pressure exists)—and resuming its elastic character, by diminution or removal of pressure.

3d. Whether it would form a stratum, distinct from water, must depend upon the existence or absence of affinity

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* Forwarded to the author in a letter from the Editor.

† Jones' Mechanics' Mag. IV. 2.

‡ Phil. Transac. London, 1823.

between the two fluids, and upon their relative specific gravity.

4th. That any particular effect of pressure upon air may take place, deep in the ocean, must of course depend upon the fact that air is conveyed to the region supposed.

5th. No cause is obvious, that can produce such an effect; the extensive contact of air and water, however often repeated, can do no more than saturate water with air, at the particular temperature and pressure.

6th. In this condition, and upon the surface of the globe, the water and the air form, apparently, a homogeneous fluid, and should this fluid descend to the greatest depth, and be subjected to ever so many miles of pressure, it is not perceived that the air and water would probably separate, or undergo any other change than a diminution of volume, as proved by Mr. Perkins' experiment on the compressibility of water.

7th. Could air be forced down through and beneath a superincumbent ocean, of the depth supposed, then it would be in a suitable condition to receive the effect of the pressure; but air, already united to water at or near the surface, has already become a fluid by the union, (or a constituent of a fluid,) and will probably undergo no other change than a mere fluid undergoes.

8th. Is it physically possible, that any aerial body should be subjected to such a pressure, as to acquire a specific gravity greater than that of water, and still retain its aerial form? Would not the supposed approximation of its particles necessarily cause it to become a fluid; and is it not physically possible that by increased pressure it may become even a solid?

Answer to the Objections.

No. 1 and 2. Experiments made in Paris, prove that air may be condensed above the density of water, without losing its elastic or gaseous properties; the point at which it is condensed into a liquid being beyond that density.

No. 3. Why should it not form a stratum under water, its density being greater, and the two fluids having combined as far as their affinity goes?

No. 4 and 5. True, that the air should be conveyed to the lowest regions of the ocean, is a consequence of its whole mass being saturated with it.

No. 6 and 7. That the air should separate from water saturated and compressed, is deduced by analogy, from what happens at the surface, as is explained in the article itself.

No. 8. The best answer to this last, and perhaps to all the other objections, is to copy here an extract of the PHILOSOPHICAL TRANSACTIONS, 1826. On Compression of Atmospheric Air, by Perkins. "In the course of my experiments on the compression of atmospheric air, I observed a curious fact, which induced me to extend the experiment; viz: that of the air beginning to disappear at a pressure of five hundred atmospheres, evidently by a partial liquefaction, which is indicated by the quicksilver not settling down to a level with its surface. At an increased pressure of six hundred atmospheres, the quicksilver was suspended about one-eighth of the volume up the tube or gasometer. At eight hundred atmospheres it remained about one-third up the tube; at one thousand atmospheres, two-thirds up the tube, and small globules of liquid began to form about the top of it; at twelve hundred atmospheres the quicksilver remained three-quarters up the tube, and a beautiful transparent liquid was seen on the surface of the quicksilver, in quantity about $\frac{1}{2000}$ part of the column of air."

From these experiments, it follows as a fact, that under the pressure of eight hundred atmospheres, two-thirds of the air is still under an aerial form, although its density is then equal to that of water; and even at twelve hundred, when it is much denser, one-third of it is not liquefied. This is sufficient for us to maintain that under the pressure of the sea a layer of air may produce the effects we have endeavored to describe.

N. B. We regret that the beautiful experiments of Mr. Perkins on the compressibility of water have not been performed upon water at forty degrees of temperature, its greatest natural condensation, instead of fifty degrees, and upon water entirely deprived of air; this would be a still greater proof that water itself is condensed, and not the air it contains, or not that the caloric, which dilates it, is repelled by compression. By similar reasons, the compression of air should have been performed on air perfectly dry, that it might not be objected that some water has been liquefied; and the experiment performed also on oxygen and azote separately, to show, whether these gases liquefy each at the same pressure when they are not combined as in the atmospheric air.

Art. IV.—*Descriptive Arrangement of Volcanic Rocks; by* G. Poulett Scrope, Esq., M. G. S.

[Communicated by the Author, to the English Journal of Science, &c. No. 42, for July, 1826.]

In the course of a series of investigations of the geology of volcanic districts, the writer of this paper has met with great inconvenience from the want of a fixed nomenclature and mineralogical classification of this family of rocks.

MM. Cordier and Fleurian de Bellevue, in two well known memoirs,* proposed a systematic arrangement of volcanic rocks on mineralogical principles; which, however, has not as yet got into general use, owing perhaps to some obvious imperfections in the mode of arrangement.

M. D'Aubuisson followed these writers in classing the pyrogenous rocks into two main families, trachyte and basalt; according to the prevalence of felspar or augite in their composition, and these terms have since been generally adopted on the continent.

But of late great confusion has been introduced into the subject by the determination of M. de Beaudant,† and after him of M. de Humboldt,‡ to confine the terms Trachyte and Basalt to rocks of a particular age and position in the geological series. The attempt has originated in an unfortunate mistake of these distinguished geologists, who have been led by their observations to presume, that rocks of the mineral character of trachyte never occur superposed to their own conglomerates, or to tertiary strata. That this notion is false in fact, may be proved by numerous examples from the Mont Dor, Cantal, and Italy. But, had it been true, still it is by no means allowable to employ the mineralogical title of a rock to designate its place in a geological series. This is the more strange in the latter author, because he talks of granites of different ages, of syenites and porphyries of primitive and transition formations, &c.; and because he ever expresses himself in these positive words; "There are trachytes, phonolites, basalts, obsidians, and perlites, of *different ages*, just as there are different formations of granite,

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* Cordier. Essai sur les Roches Pyrogenes de tous les Ages.—*Journal de Physique.* Fleurian de Bellvue.—*Journal de Physique,* tom. lxxxiv.

† Beudant. *Hongrie,* tom. iii.

‡ Humboldt. *Essai Geoligique.*

gneiss, mica-schist, limestone, grey-wacke, syenite, and porphyry." How then, after this, could the same author confine the term trachyte, basalt, and phonolite, to rocks of a particular epoch, and vaguely unite all the rocks mineralogically identical with them, but bearing appearances of a later date, under the undescriptive, undistinctive term "Lavas." How much more simple, after such a confession of the different ages of the same rocks, to name them geologically by means of epithets superadded to their primary mineralogical designation, in the same manner as the other rocks are treated. We should then have secondary trachytes, tertiary trachytes; or, if it was preferred, trachytes of the new red sandstone, trachytes of the greensand, recent trachytes, &c.

It is so obvious that the determination of the mineral characters of a rock must precede any attempt to find its place in a geological system, since it is *only* by these characters that it can be distinguished from the other rocks with which it is associated, that it is difficult to believe any person would dispute the propriety, not to say the necessity, of a mineralogical nomenclature being made use of for the *primary* terms of a geological classification. In fact, such a classification is a Tabular History of Rocks, or of the globe's surface, and requires a great deal of previous description and comparison of all these rocks according to their mineral nature. It is also founded on hypothetical views, since it is a mere hypothesis, and perhaps a false one, more particularly with respect to the elevated strata, and, above all, the unstratified rocks, that *superposition* is any proof of a posterior origin. The arrangement of rocks on such a basis must necessarily be dubious, insecure, and often erroneous. Whereas no error can be committed in a nomenclature which is merely descriptive, and founded on oryctognostical principles. The character inferred by the name must always be true of the rock to which it has been applied; all speculative ideas as to age or origin are kept out of view; at the same time that this arrangement displays the various rocks known in a clear, concise, and ready manner, for the purpose of any ulterior classification upon geognostical or geological principles that may be preferred.*

* The utter absurdity of making the primary or only name of a rock indicative, not of its mineral nature, but its geological connexions, is instantly seen, by supposing that this principle were acted on, not in one or two, but in all

These considerations will perhaps evince the propriety and utility of generally adopting some such descriptive nomenclature for all classes of rocks, as that which is here proposed for those of unquestionable volcanic origin, or the *pyrogenous rocks.* The end which the writer has had in view is to offer concise and comprehensive definitions of the principal oryctognostical characters of this family of rocks, by the use of which any one of its members may be distinctly described by an observer in a manner intelligible to all geologists.

The *primary* characters by which alone the nature of a rock or mineral mass, simple or compound, can be identified, are those of its mineral composition, texture, the relative disposition of its component minerals, if a compound rock, its internal structure, and natural divisions.

The colour, lustre, fracture, hardness, fusibility, and specific gravity of rocks are obviously determined by their qualities of mineral composition or texture, and must vary with them; these therefore are secondary characters, not characteristics. Of the primary qualities, that of mineral composition is obviously by far the most important towards identifying the rock. All the other characteristics are probably accidental modifications determined by the mineral composition, under the influence of external circumstances; whereas it is difficult to conceive this latter character to be in any way influenced by the others, under any circumstances.

Hence the *mineral composition* of the rocks under review at present has been taken as the basis of their systematic arrangement into genera and species; the sub-species and va-

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cases; the consequence of which would be, that we should have no names whatever; for to say that granite is a rock determined by its underlying gneiss; gneiss characterized by its underlying mica-schist, and this by its bearing the same relation to clayslate; and so on, would be to pursue the most vicious of all circles, since we can have no means of distinguishing an over from an underlying rock, but by their distinctions of mineral character: these must therefore be determined, and the mineralogical characteristics of each rock defined, (which cannot be done without applying some name to it,) *before* their relations of position can become a question. To force the *primary* name of a rock to denote its supposed place in a geological series, would be as inconvenient and irrational as to confine the name of a simple mineral to one found in a particular locality, so that, when met with in another, a new name must be invented for it; or to give, for instance, the name of felspar to this mineral only when in company with mica, and refuse it the appellation when associated with quartz. Hence arises a *general rule*, that when a rock possesses but *one name*, it is significative of its mineralogical character.

rieties being distinguished, according to the remaining primary characters, under the separate heads of—

1. Texture.
2. Mineral disposition.
3. Internal structure.
4. Natural division.

There is, however, one previous distinction which it is incumbent to draw between the rocks of the trap family, and which is rather of a geological than mineralogical nature; viz., their division into the two *classes* of *lithoidal* or *massive*, and *fragmentary* rocks; according as they are composed of minerals intimately united by the force of crystalline aggregation; or merely of separate parcels of matter, incoherent, or enveloped in a cement, whether crystalline or earthy, but evidently of later origin than the fragmented portion it encloses.

The second step is to arrange the lithoidal rocks into genera, according to their broad general characters of mineral constitution. Now it has been ascertained that all the rocks of this family, with very few exceptions, are principally composed of felspar and augite in varying proportions. The felspar is sometimes partially or wholly replaced by leucite, melilite, olivine, or hauyne; and this substitution is observed only to occur when the proportion of augite in the rock is very considerable. The augite appears in the same manner, occasionally replaced to a greater or less extent by mica; and this occurs only when the felspar is greatly in excess. The augite is either pyroxene or hornblende, the one seeming to replace the other in proportion to the abundance of felspar. Titaniferous iron and sphene are subordinate but very general ingredients in these rocks; the former is often in considerable quantity, and abounds most in the augitic species. Quartz occurs very rarely in crystals or grains; garnet, spinelle, sapphire, and other still rarer minerals can only be reckoned as accidents.

It is seen then that these rocks naturally group themselves into two principal orders; viz.—1. That in which felspar predominates exceedingly. 2. That in which augite or the ferruginous minerals are in excess; or at least so abundant as to stamp their character on the rock. This is, in fact, the division which has been generally made by the continental geologists, who have called the former order *trachyte*, the latter *basalt*.

But the shades of mineral composition amongst the compound rocks of this family are so varied in nature, and graduate so imperceptibly into one another, that two genera alone can hardly be reckoned sufficient.

A very numerous tribe of rocks is to be met with, in which the proportions of felspar and augite are such, that it is impossible to tell which predominates, while, in their general characters, the rocks are so unlike the extremes of either genus, that it is scarcely allowable to rank them together. It appears from these reasons expedient to institute an intermediate class of rocks, for the reception of those members which cannot, without difficulty, be referred to either of the two extremes. The name which I conceive most appropriate to them, as having been applied to such rocks already by Werner and other mineralogists, and as susceptible of little misconception, is greystone, (graustein,) their color being universally of some tint of grey, generally lead-grey, greenish, iron, purplish, or slate-grey, with the exception only of their vitrified varieties, some of which have assumed a black color, which, however, passes away under the blowpipe, and is succeeded by the usual grey tint.*

The genera of the volcanic, or trap family of rocks, will then consist of—

I. Trachyte.
II. Greystone.
III. Basalt.

It may, perhaps, be objected to the basis of this arrangement, that these subjects frequently appear homogeneous, and hence their constituent minerals are undiscoverable. This is, however, far from the case. There are very few rocks of this family, indeed, in which a good lens, or at furthest, a microscope, will not discover a granitoidal mixture of the constituent minerals in a crystalline form. The method of mechanical analysis, first proposed by M. Cordier, will determine this with accuracy and certainty. But, for ordinary purposes, examination with a lens will be sufficient, and even the color may be generally depended on as an accurate criterion, unless the rock is passing to a resinous or vitreous

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* Greystone corresponds in part to the class of volcanic rocks called tephrine, by M. de la Metherie. It comprehends also the majority of clinkstones.

state, under which circumstances the lightest colored felspar rocks sometimes assume a blackish hue.*

Speaking generally, the colour of the mass is deeper in proportion to the quantity of augitic matter in its composition, the felspar being always of a light colour, the augite a darkish green or black, and the iron a dark-brown or black. The proportion of felspar, or its substitutes, which exists in trachyte, may be reckoned at, or above, ninety per cent., the remainder being composed of augite, or the ferruginous minerals. In greystone, felspar or its substitutes composes more than seventy-five per cent.; when these minerals are in less proportion than seventy-five per cent., the rock should be classed as basalt.

Another auxiliary test, in which greater confidence may be reposed, is the specific gravity of the substance when reduced to powder. In fact, the specific gravity of the augitic and ferruginous minerals is so greatly superior to that of felspar, that an observation of this nature will indicate the general proportion of these two classes of minerals in any volcanic rock. In general, the specific gravity of trachyte will be found not to exceed 2.7, that of greystone 3.0, while basalt occasionally reaches 3.50, which is much above the specific gravity of augite alone, and caused by the presence of a quantity of iron in a metallic state.

A third test consists in the colour of the glass, produced by fusion of the mineral before the blowpipe. That resulting from trachyte is light coloured, and nearly transparent. The glass of greystone is darker, and spotted with numerous green or black specks, often of a green colour, bearing a constant ratio to the proportion of ferruginous minerals in the rock. Basalt melts into a dark green, or black enamel. Observations which have often been made on these rocks, and which, without being insisted on as infallible criteria, will yet often assist in distinguishing them, are—

1. That leucite has not been found to occur in any trachyte, only making its appearance when the proportion of the heavier minerals is considerable; rarely in greystone, oftener in basalt.

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* Apparently derived from the bitumen, which appears, from chemical analysis, to be present in this condition of the rock, and which is volatilized on exposure to the blowpipe.

2. Olivin never has been met with as yet but in basalt; it appears to replace the felspar, in part or altogether, only when augite is in excess.

The specific divisions of these genera should be drawn from minor modifications of mineral constitution: a tabular view of the principal species is subjoined:

Genus I.—Trachyte, characterized as above.

Species A. Compound trachyte with mica, hornblende, or augite, sometimes both, and grains of titaniferous iron.
" B. Simple T., without any visible ingredient but felspar.
" C. Quartziferous T., when containing numerous crystals of quartz.
" D. Siliceous T., when there appears to have been introduced a great deal of silex into its composition.

Genus II.—Greystone.

" A. Common greystone, consisting of felspar, augite, or hornblende and iron.
" B. Leucitic greystone, when leucite supplants the felspar.
" C. Melilitic greystone, when melilite is substituted for that mineral, &c.

Genus III.—Basalt, characters as above.

" A. Common basalt, composed of felspar, augite, and iron.
" B. Leucitic B., when leucite replaces the felspar.
" C. Basalt, with olivin in lieu of felspar.
" D. Basalt, with hauyne in lieu of felspar.
" E. Ferruginous basalt, when iron is the predominant ingredient.
" F. Augitic basalt, when pyroxene or hornblende composes nearly the whole of the rock.

The character which ranks next in importance, towards the descriptive qualification of a volcanic rock, is its *texture*, and by this character the sub-species may be, with propriety, distinguished.

All lithoidal volcanic rocks, with the exception only of those which have partly, or wholly, passed by complete fusion into the state of glass, consist of an aggregation of more or less imperfect crystals of one or more minerals.

The average size of these crystals, or integrant particles, determines the *grain* of the rock, which is one of the elements of its texture. When the average size of the crystals is so large as to strike the eye by its crystalline structure at a distance, as in granites, the texture is called *granitic;* when of such size as to be discerned only by close inspection, *granular;* and when so minute as to require a lens to ascertain its crystalline texture, or the assistance of the mechanical analysis, *compact.* When the rock appears to be passing to the state of a glass or enamel, assuming a pearly, waxy, or resinous lustre, its texture is called *resinous*, or *semi-vitreous;* and lastly, the finest texture of all is the *vitreous*, or *glassy.*

But, besides the size of the crystalline particles, another character influences the *texture* of the rock, viz., their more or less intimate aggregation, which may be *loose* and incoherent, giving an *earthy* aspect to the rock; or *close* and compact, producing the effect of *hardness* and solidity. Another and still more important characteristic is, the regular or irregular *disposition* of its component crystalline particles, which are sometimes aggregated in a confused and disorderly manner, without any determined method, so as to give an irregular fracture to the rock, as in granite, claystone, &c.; at others, they are arranged so that their longest plane surfaces preserve a more or less perfect parallelism to one another, through a considerable space, by which a *foliated*, or *scaly* texture is given to the rock, and a splintery or slaty fracture, as well as a lamellar or schistose structure, on a large scale. This remarkable difference in the diposition of the crystalline particles is always found to pervade the whole mass of rock, and, in fact, forms the only distinction between granite and gneiss, claystone and clinkstone.

Hence, according to the arrangement proposed here, the sub-species of the volcanic rocks should be distinguished by epithets significative of their peculiar texture, viz.

A. Granitic		
B. Granular		
C. Compact	*a* Massive, or granitoidal.	Loose *α*.
D. Resinous	*b* Scaly, or foliated.	Close *β*.
E. Vitreous		

The texture is also either, 1. *Uniform*, which needs no explanation, or, 2. *Varied*, when consisting of parts of different texture. Epithets may be also made use of to describe the general form and disposition of these parts, as, 1. Nodular. 2. Lenticular. 3. Zoned. 4. Brecciated.

These varieties of texture in the same mass are generally connected with, and in all probability owing to, an unequal distribution of the different minerals composing the substance, which forms another very characteristic distinction amongst this family of rocks, and may with propriety be assumed as the basis of their division into *varieties*. The principal modes of mineral distribution are—

1. *Uniform*, when the minerals are generally intermixed throughout the mass, as in granites, syenites, &c.

2. *Porphyritic*, when large crystals, or grains, of one or more minerals are dispersed throughout a base of very fine texture, and uniform disposition, so as to strike the eye by their prominence, as in porphyries.

3. *Globular concretionary*, when some minerals have more or less completely separated themselves from the remaining mixture, and agglomerated into globular nuclei, as in pearlstone, variolite, orbicular granite, &c.

4. *Nodular concretionary*, when some minerals have separated in the form of irregular knots, as in the masegna of the Euganean hills, in many granites and porphyries, or like the flints in chalk.

5. *Lenticular concretionary*, when the figure of the segregated parts is much elongated in any one direction.

6. *Zoned concretionary*, when they are elongated still more into alternate stripes.

7. *Veined*, when one or more species of minerals appear to have occupied cracks in the rock.

8. *Amygdaloidal*, when one or more minerals have occupied vesicular cells in it.

The next head under which it has been thought right to class the characteristic qualities of these rocks, is their *internal structure*, which comprehends the following varieties:—

1. Massive, or compact.
2. Porous, as are all loose-textured, earthy, and bibulous rocks.
3. Cellular, when the cavities are visible to the eye, but irregular and angular.
4. Vesicular, when the cells are more or less spheroidal.
5. Cavernous, when the blisters or air-cells are of a very large size, and very numerous.
6. Spumous, when the air-cells are so numerous as to give a lightness and frothy appearance to the rock, as in some varieties of pumice and scoria.
7. Filamentous, when composed of twisted thread-like fibres.

The last head to be noticed in the description of this class of rocks is their *divisionary structure ;* by which is meant the figures or the parts into which the rock is divided by seams or natural clefts. Frequently there are no such separations of continuity, and the rock is then pronounced *amorphous*. The varieties of divisionary structure may be classed as—

1. The bedded structure, when divided into massive beds.
2. Stratified, when the beds are less bulky, from the greater frequency of the seams.
3. Tabular, when the separate divisions are still thinner, flat, and of no great longitudinal extent.
4. Laminar, when still thinner.
5. Schistose, lamellar, or slaty ; a well known structure.
6. Columnar, when the divisions are regular many-sided prisms of considerable length.
7. Prismatic, when the form of the prisms is less regular, and the transverse joints more frequent.
8. Rhomboidal, when there exists a double system of parallel seams, dividing the mass into portions approaching in figure to cubes or rhomboids.
9. Conchoido-prismatic, when the boundaries of these portions are curvilinear.
10. The *globiform*, when the rock is divided into globular masses of a large size. These are often subdivided into concentric laminæ, less frequently into radiating prisms, or even columns.
11. The globular, when the spherical concretions are very small.

12. The angulo-globular, when the rock separates into small angular divisions rudely approaching to a globular form. It resembles the conchoido-prismatic structure on a very small scale.

The *secondary* characters of these rocks are often of service towards ascertaining with greater precision their primary qualities, and thus accurately *defining* the rock. They consist chiefly of—

1. The *lustre* and *fracture;* both of which depend upon, and consequently disclose, the *texture* of the rock.

2. *Hardness*, which indicates the mineral composition.

3. *Solidity*, or the coherence of its integrant parts, which depends upon texture.

4. *Fusibility*, which varies somewhat with the size of the grain; the smallest grain melting most readily *cæteris paribus;* but it depends chiefly on the mineral composition of the rock, of which it becomes a serviceable test.

5. *Colour* usually indicates the mineral nature of the rock, unless it is stained by metallic oxides, or other accidental modifications, which are in general easily distinguishable from the genuine tint of the component minerals.

Each of the three genera of lithoidal volcanic rocks possesses their conglomerates, which may be referred to any of them, according to the mineral nature of the composing fragments. They thus are divided into—

1. Trachytic conglomerates. 2. Greystone ditto. 3. Basaltic ditto.

The primary characters of these conglomerates, by which they are most distinctly recognized and described, consist of—

1. The average size of the fragments; which may be called,

A. Coarse, when of a considerable size.

B. Gravelly, when of a medium size.

C. Sandy, or arenaceous.

D. Fine.

E. Argillaceous.

F. Mixed, when fragments of one size or more are imbedded in a base or cement of finer materials. The cement is occasionally of crystalline texture.

2. The form of the fragments must also be noticed. This is either,

α. angular, β. water-worn, γ. rolled.

3. The fragments should be referred, if possible, to some mineral species of lithoidal rocks, and their varieties, if any, taken notice of; as well as the occurrence of isolated crystals, rare minerals, shells, wood, &c.

4. The solidity of the conglomerate rock; which may be,

A. incoherent, or earthy, B. indurated.

5. The divisionary structure, which is occasionally met with in conglomerate as well as in lithoidal rocks, and is subject to the same varieties of form.

The volcanic rocks, both lithoidal and conglomerate, are sometimes found in an altered state, from having been exposed to the decomposing influence either,

1. Of proximate emanations of aqueous vapours charged with sulphuric and muriatic acids; or,

2. Of the ordinary atmospheric agents.

In the first case, the alumine and potass of the felspar and augite are taken up by the sulphuric acid, and deposited by the agency of water, as sulphat of alumine (alumstone,) in the cavities aud fissures of the rock, and in neighbouring hollows; leaving the remainder of the rock, composed almost solely of silex, in a carious state, but often filled up with other infiltrated matters as well as alum, and stained with ferruginous oxides, from the union of its iron with the oxygen of the acids. In the second case, the decomposition of the augite and felspar, sometimes of one, at others of both, produces a variety of argillaceous earths or *boles*, giving to the rock, which is then often called *wacke*, a more or less argillaceous aspect, proportionate to the degree of decomposition, and sufficient to render it occasionally difficult to recognise its original mineral composition. These boles are sometimes conveyed by aqueous infiltrations into the cellular and other cavities of the rock, giving occasion to the amygdaloidal composition.

The object proposed in the foregoing remarks is to endeavour to establish a fixed nomenclature for the principal characteristics of the volcanic rocks, so as to enable any observer to define or describe all their varieties accurately and distinctly, for the ulterior purposes of geology. Names may be subsequently given by geologists to any of these varieties, for the sake of avoiding a redundancy of words, or not, as convenience may dictate. A number of appellations have indeed been given, and confirmed by general use, to particular varieties; some of which it may be as well to specify in this place. Thus the granular, massive, and earthy sub-species of trachyte has been called in England *claystone;* in France, *domite; necrolite*, by Brocchi. Compact and close-grained trachyte has received the name of compact felspar, and perhaps of hornstone; the laminar sub-species of the same rock, clinkstone, (phonolite ;) and this name being appropriated to a peculiarity of texture, is given as well to greystone and basalt, as to trachyte, when possessed of that character.

Resinous trachyte is generally known by the name of pitchstone; *vitreous* by that of obsidian; and the same when formed into globular concretions, perlite or pearlstone; and the same vitreous basalt has been called gallinace by the French geologists.

Spumous and filamentous trachytes are called *pumice.* Spumous greystone and basalt, *scoria.*

When porphyritic, many of these varieties have been called porphyries; as claystone porphyry, pitchstone porphyry, &c. Large grained or granitic basalt has the title of *greenstone* (dolerite.) Very coarse grained trachytes have, perhaps, often been described as syenites.

With regard to the conglomerates, the sandy and fine-grained varieties of trachytic conglomerate are generally called tufa, sometimes trass; the coarse and incoherent, lapillo. Those of greystone also usually bear the same appellations. The basaltic conglomerates are occasionally styled peperino, or trap-tuff; but when fine, or sandy and incoherent, puzzolana. Some fine tufas, indurated by water, and, with a lamellar structure, have been made use of and described as tripoli. Basaltic conglomerates, when much decomposed, have been designated by the term wacke, as well as the congenerous lithoidal rock when in a similar condition.

Art. V.—*The Report of* J. L. Tiarks, *Astronomer on the part of his Britannic Majesty under the sixth and seventh Articles of the Treaty of Ghent: on his Astronomical Observations for ascertaining the most northwestern point of the Lake of the Woods.*

(Communicated by Prof. Renwick, for insertion in this Journal.)

In order to explain the operations by which I have endeavoured to ascertain the most northwestern point of the Lake of the Woods, it will be necessary that I should give a definition of the term "most northwestern," and explain the property, which a point of a lake must possess, in order to entitle it to the appellation the "most northwestern." In so doing, I hope I shall not overstep the province of the astronomer, who is supposed to be qualified to give definitions of terms connected with his science. If there should be a difference of opinion on the meaning of the words "most northwestern," I shall humbly offer that definition which appears to me to be the true one, with due deference to the judgment of the Honorable Board of Commissioners, in order to render intelligible the operations which I have performed, and the conclusions at which I have arrived, on this subject.

The most northwestern point of a Lake appears to me to be the point which has the following property, viz: that if a loxodromic line be drawn from it, intersecting every meridian in the direction from southwest to northeast, at an angle of forty-five, and such loxodromic line be continued, both ways if necessary, to its intersection with the meridian of the extreme eastern and western points of the lake, this line shall touch no other water of the lake. It is well known, that on Mercator's projection, all loxodromic lines become straight lines, and the solution of the problem conformably to the definition here given, becomes, therefore, more simple by projecting the lake, the most northwestern point of which is to be ascertained, in this manner, on a plain surface. On such a projection, that point of the lake from which a northeast and southwest course can be drawn, without touching or intersecting any other point of the lake, is the most northwestern one; and in order to ascertain which of two given points is the more northwest, it will be sufficient to connect the two points by a straight line on the map, (projected according to Mercator.) If the angle formed by this line, and one of the parallels of the map, be more than an angle of 45°, the northern point is the more northwest; if less, the southern is the more northwest; if 45° exactly, the two points are equally northwest. It will be easily seen, that if through the southern one of the two points, which are thus to be compared, a parallel of latitude be drawn, and through the northern one a meridian, and those lines be continued until their intersection, a right angled triangle will be formed, the hypothenuse of which is the straight line, connecting the two points in question, or the course from the one to the other, and the two cathetes the difference of longitude and the difference of latitude of the two points on the map. The angle formed by the connecting line of the two points with the parallel is exactly 45°, if the difference of longitude on the map is equal to the difference of latitude; it is $\left\{\begin{matrix}\text{more}\\ \text{less}\end{matrix}\right\}$ than 45°, if the difference of latitude be $\left\{\begin{matrix}\text{more}\\ \text{less}\end{matrix}\right\}$ than the difference of longitude, both being measured on a map projected on Mercator's principles. If therefore the differences of latitude and longitude be expressed in figures, in the same manner, for example in minutes of a degree, on the principle of Mercator's projection, these numbers will immediately show which is the more northwestern one of the two points. The degrees of longitude are all equal on Mercator's projection, and may be easily expressed in any manner required. The degrees of latitude increase from the Equator to the Pole: the expression of the length of a meridian from the Equator to the latitude L., in minutes of a degree, is $= 7915' 7044674$ log. tangt. $(45° + \frac{1}{2}$ L). The numbers resulting from this formula for the different degrees and minutes of latitude are contained in the common books of navigation, under the head of "meridional parts." From all this, it will appear, that in order to ascertain which is the more northwestern one of two points, the longitude and latitude of which are given, it will be necessary to find by the above formula the numbers corresponding to the two latitudes, and to take the difference of the same; and likewise to take the difference of longitude of the two points, and express it in minutes of a degree, (which numbers thus express by a common measure the difference of longitude and latitude on Mercator's projection,) and if the former number is $\left\{\begin{matrix}\text{greater}\\ \text{less}\end{matrix}\right\}$ than the latter, the $\left\{\begin{matrix}\text{northern}\\ \text{southern}\end{matrix}\right\}$ point is the more northwestern one.

The map of the Lake of the Woods, which Mr. Thompson has constructed from his surveys, proves, that there are two points on this lake which are more northwest than all other points of the lake, and so nearly equally northwest as to require a more accurate comparison, in order to pronounce with certainty which of them is, according to the principles above explained, the most northwestern point of the Lake of the Woods. These two points are: 1. the most northwest point of a deep bay, on which Mr. Thompson has placed his monument No. 1, (in latitude 46° 23′ nearly.) 2. The most northwest point of the bay on which the beginning of the Rat Portage is situated, (in latitude 49° 46′ nearly.) The accuracy with which Mr. Thompson has laid down the relative position of these two points, considering the manner in which this survey was necessarily conducted, which will appear from comparing his maps with the results of my astronomical observations, is a proof that the conclusions which have been drawn from the map with regard to the situation of the intermediate points, are perfectly just, and that all these points are less northwest than the one above mentioned. With a view, therefore, of comparing the situation of those points, I have endeavoured accurately to ascertain their difference of longitude, and their latitude, for which purposes the following observations were made. I have used an excellent sextant, of nine inches radius, made by Mr. Troughton, and two pocket chronometers, one made by Arnold, (No. 2111,) and the other by Morice, (No. 201.)

The most northwest point in the neighbourhood of Mr. Thompson's monument, No. 1, having no camping ground near it, I thought best to make my observations at the monument itself, and to connect this point with the other by actual measurement.

MR. THOMPSON'S MONUMENT NO. 1.

Circummeridian Observations of the Sun's Altitude for determining the Latitude. { Index error — 7″ 5, Thermometer 75°

Time by Arnold 2111.	Double Alt. of Sun's U. L.	Time by Arnold 2111.	Double Alt. of Sun's L. L.
July 27. 0h 0′ 40″2	120° 7′ 30″	July 27. 0h 6′ 58″2	119° 6′ 30″
1 29	8 15	7 6 2	6 35
2 15 2	8 50	8 16 2	6 15
4 2 3	9 25	10 27 3	5 15
14 33	4 45	11 12 3	4 50
17 12 4	0 50	12 17	4 5
18 11 3	119 58 40	13 3 3	3 10
19 6 4	56 50		

Result:	Zenith distance of Sun's centre at noon,	30°	10′	52″	70
	Refraction less parallax, - - - -			27	90
	Sun's declination, - - -	19	11	43	00
	Latitude of Thompson's Monument No. 1,	49	23	3	60

I arrived at Mr. T.'s monument near noon; it was cloudy the whole afternoon, and consequently no observations for determining the time were made this day, (July 27.)

MR. THOMPSON'S MONUMENT NO. 1.

Circummeridian Observations of the Sun for determining the Latitude. { Index error + 2″½, Thermometer 75°

Time by Arnold 2111.	Double Alt. of Sun's U. L.	Time by Arnold 2111.	Double Alt. of Sun's L. L.
July27. 23h 58′ 25″	119° 37′ 25″	July28. 0h 4′ 26″	118° 38′ 25″
59 0	38 10	5 6	38 50
59 31	39 0	6 18	38 55
59 57	39 20	6 46	38 50
28. 0 1 34	40 0	7 25	38 40
2 32	40 40	8 4	38 30
3 13	41 10	8 32	38 10
9 51	41 10	9 12	37 50
10 20	41 0		
11 4	40 20		
11 41	39 50		
12 37	38 40		
13 27	37 50		
15 37	34 50		
16 11	34 15		
16 45	33 43		
17 32	31 50		
17 59	31 20		
19 5	28 40		
20 18	26 50		
20 52	25 0		

Result:	Zenith distance of Sun's centre at noon,	30°	24′	45″	80
	Refraction less parallax, -			28	22
	Sun's declination, - -	18	57	55	22
	Latitude of Mr. Thompson's Monument No. 1,	49	23	9	24

Mr. Thompson's Monument No. 1.

Equal Altitudes of the Sun for ascertaining the time.

Double Altitude of Sun's U. L.	Times before noon.	Times after noon.	By Arnold 2111.
96° 0	July27. 21h 39′ 15″	July 28. 2h 33′ 17″	
20	40 28	32 5	
30	41 8	31 27	
97 40	45 25	27 8	
50	46 3	26 31	
98 0	46 39	25 54	
10	47 17	25 16	
20	47 53	24 38	
30	48 31	24 1	
40	49 10	23 23	
50	49 46	22 45	
99 20	51 40	20 51	
30	52 19	20 14	
40	52 58	19 35	
50	53 35	18 56	
100 0	54 15	18 9	

Results: Uncorrected noon by the mean of all observations, - - -	0h 6′ 16″ 31
Correction, - - -	8 43
Apparent noon, - -	0 6 24 74
Mean time at the apparent noon, -	1 6 6 38
Arnold 2111 fast of the mean time of Mr. Thompson's Monument No. 1, on July 28, at noon, -	0 18 36

Station near the Rat Portage.

Altitudes of the Sun for ascertaining the Time. { Index error + 2″ ½ ; Thermom. 74° }

Time by Arnold 2111.	Double Altitude of Sun's U. L.	Time by Arnold 2111.	Double Altitude of Sun's L. L.
J'ly29. 20h 54′ 14″5	82° 41′ 40″	July29. 20h 57′ 39″	82° 39′ 30′
54 59	55 15	58 30	54 25
55 54	83 12 0	59 14	83 7 30
56 29	22 10	59 47	17 40
57 2	31 30	21 0 22	27 50

Result of the observations of the Sun's Upper Limb: Arnold slow 2′ 9″ 89	Result of the observations of the Sun's Lower Limb: Arnold slow 2′ 9″ 52

Mean Result of all Observations.

Arnold 2111. Slow of the mean of the Rat Portage station, July 29, -	20h 59′ 33″ M. T.
	2 9 70

It was cloudy the whole afternoon of the 30th July, and I obtained no corresponding altitudes to a numerous set of altitudes, which I had taken in the morning.

Station near the Rat Portage.

Circummeridian Observations of the Sun for determining the Latitude. { Index error + 2″ 5; Thermom. 76°

Time by Arnold 2111.	Double Altitude of Sun's U. L.	Time by Arnold 2111.	Double Altitude of Sun's L. L.
J'ly29. 23h 49′ 41″	117° 44′ 20″	J'ly29. 23h 55′ 26″	116° 50′ 40″
50 40 5	46 15	56 6	51 50
51 16	47 45	56 45	52 20
52 04	49 20	57 22	53 10
53 4 5	51 0	58 1	53 55
53 43	51 50	59 24 5	54 50
30. 0 13 9	52 40	30. 0 0 31	55 0
14 24 5	50 40	1 2	55 30
19 23 5	41 0	1 36	55 40
		2 23 5	55 40
		4 44	55 50
		6 2	55 45
		7 22 5	55 20
		8 54 5	54 20
		11 1	52 0
		11 31	51 30
		12 35	50 15

Result: Zenith distance of the Sun's centre at noon,	31° 16′ 0″ 97
Refraction less parallax, - - - -	29 23
Sun's declination, - - - - -	18 29 25 90
Latitude of the station near the Rat Portage,	49 45 56 10

Mr. Thompson's Monument No. 1.

Altitudes of the Sun for ascertaining the Time. { Index error + 2″ 5; Thermom. 69°

Time by Arnold 2111.	Double Altitude of Sun's U. L.	Time by Arnold 2111.	Double Altitude of Sun's L. L.
July 31. 4h 46′ 58″	53° 36′ 10″	July 31. 4h 53′ 1″	50° 54′ 30″
47 32	24 40	53 49	18 50
48 16	10 25	54 48	0 20
48 56	52 57 30	55 50	49 39 30
49 30	46 20	56 50 5	20 5

Result of the observations of the Sun's Upper Limb: Arnold 2111 fast 0′ 5″ 58

Result of the observations of the Sun's Lower Limb: Arnold 2111 fast 0′ 5″ 54

Mean Result of all Observations.

Arnold 2111, fast of the mean time of Mr. Thompson's Monument No. 1, on July 31st, 4h 51′ M. T. - 0′ 5″ 57

Station near the Rat Portage.

Equal Altitudes of the Sun for ascertaining the Time.

Double Altitude of Sun's U. L.		Times before midnight.	Times after midnight.	By Arnold 2111.
30°	10′	Aug. 1. 5h 56′ 11″	Aug. 1. 18h 11′ 31″	
	0	56 42	10 58 5	
29	50	57 14	10 26 5	
	40	57 45	9 55	
	30	58 18	9 23 5	
	20	58 49 5	8 51 5	
	10	59 20 5	8 21	
	0	59 53	7 47 5	
28	50	6 0 24	7 18	
	40	0 56	6 45 5	
Double Altitude of Sun's L. L.				
27	10	2 21	5 20	
	0	2 53	4 47 5	
26	50	3 24 5	4 16	
	40	3 56	3 43	
	30	4 28	3 12	
	20	4 59	2 41	
	10	5 31	2 8	
	0	6 3 5	1 37 5	

Result: Uncorrected midnight by the mean of all observations of the Upper Limb, 12h 3′ 50″ 55
Correction, — 18 29

Apparent midnight by Sun's U. L. 12 3 32 26
Uncorrected midnight by the mean of all observations of the Lower Limb, 12 3 50 13
Correction, - — 17 99

Apparent midnight by Sun's L. L. - 12 3 32 14
" " " U. L. - 12 3 32 26

Apparent midnight by the mean of all observations, - - - - - 12 3 32 20
Mean time at the apparent midnight, 12 5 54 75

Arnold 2111, slow of the Rat Portage mean time on the 1st of August, 12h 6′. 2 22 55

Station near the Rat Portage.

Circummeridian Observations of the Sun for determining the Latitude. { Index error + 2″ 5; Thermom. 74°

Time by Arnold 2111.	Double Altitude of Sun's U. L.	Time by Arnold 2111.	Double Altitude o Sun's L. L.
Aug.1. 23h 50′ 11″5	116° 16′ 20″	Aug.1. 23h 55′ 0″	115° 21′ 5″
51 16	18 40	55 41	21 30
51 51	19 50	56 12	22 10
52 30	20 40	56 43 5	22 40
52 59 5	21 50	57 14	23 10
53 33	22 35	57 47	23 30
54 10	23 30	58 34	24 20
Aug.2. 0 2 34	29 50	59 19	25 0
3 52	29 55	Aug. 2. 0 0 6	25 20
4 35	29 50	1 23	25 50
5 14	29 30		
5 51	29 10		
6 21	28 50		
6 53	28 35		
7 32 5	28 0		
7 56 5	27 40		
8 30 5	27 30		
9 5	27 15		
9 49 5	26 35		
10 29	25 50		
16 32 5	16 20		

Result: Zenith distance of Sun's centre at noon,	32° 1′ 2″ 86
Refraction less parallax, - - - -	30 11
Sun's declination, - - - - -	17 44 23 96
Latitude of the Station near the Rat Portage,	49 45 56 93

MR. THOMPSON'S MONUMENT NO. 1.

Equal Altitudes of the Sun for ascertaining the Time.

Double Altitude of Sun's U. L.	Time before noon.	Time after noon.	By Arnold 2111.
101° 20′	Aug.3. 22h 10′ 50″5	Aug.4. 1h 59′ 56″	
30	11 33	59 14	
40	12 17	58 32	
50	13 0	57 45 5	
Double Altitude of Sun's L. L.			
101° 0′	13 59	56 49 5	
10	14 42	56 5 5	
20	15 26 5	55 22 5	
30	16 10	54 39	

Result: Uncorrected noon by the mean of all observations, - - - -	0h 5′ 24″ 00
Correction, - - - - - -	+ 9 56
Apparent noon, - - - - -	0 5 33 56
Mean time at the apparent noon, -	0 5 43 12
Arnold slow of the mean time of Mr. Thompson's Monument No. 1, Aug. 4th, 0h 5′ 7″ M. T.	0 9 56

MR. THOMPSON'S MONUMENT NO. 1.

Circummeridian Observations for determining the Latitude. { Index error + 2″ 5; Thermom. 75°½ }

Time by Arnold 2111.	Double Altitude of Sun's U. L.	Time by Arnold 2111.	Double Altitude of Sun's L. L.
Aug. 4. 4′ 3″	116° 12′ 10″	Aug. 4. 0h 16′ 30″5	114° 59′ 50″
4 34	12 35	18 51	54 50
14 40	6 10	21 42	48 50
15 14	5 0		
15 32	4 20		
15 58 5	3 50		

Result: Zenith distance of the Sun's centre at noon,	32° 9′ 38″ 93
Refraction less parallax, - - -	30 30
Sun's declination, - - - -	17 12 53 14
Latitude of Mr. Thompson's Monument No. 1.	49 23 2 37

Latitude of the two Stations.

From the mean of all observations made at the same station, the following results have been deduced:

Latitude of Mr. Thompson's Monument No. 1,	49° 23′ 6″ 48
Latitude of the Station near the Rat Portage,	49 45 56 54

Comparisons of the two Chronometers on the days on which Observations have been taken.

Days of Comparison.	Time the Chronometers showed in the same instant.	
	Arnold 2111.	Morice 201.
July 28	5h 0′ 0″	5h 1′ 5″
29	0 42 0	0 43 16
30	0 35 0	0 36 30 7
31	5 28 0	5 29 48
Aug. 1	6 8 0	6 10 3
1	18 17 0	18 19 11 5
3	9 53 0	9 55 33 3
—	20 10 0	20 12 38 6
—	22 18 0	22 20 40
4	2 3 0	2 5 41 7

From these comparisons, and the differences of Arnold 2111 from the mean time of the two stations resulting from the preceding observations, the differences of Morice No. 201 from the mean time of the same places, can be easily deduced, and we obtain the following results:

Differences of the two Chronometers from the mean time of the two Stations at the moments of observations.

Differences from the Mean Time of Mr. Thompson's Monument No. 1.

Day & fraction.	Arnold 2111.	Daily Rate.	Morice 201.	Daily Rate.
July 28. 004	+ 18″ 36		+ 1′ 20″ 63	
31. 202	+ 5 57	− 3″ 99	1 53 54	+ 10″ 29
Aug. 4. 004	− 9 56	− 3 98	2 31 28	+ 9 93

Differences from the Mean Time of the Station near the Rat Portage.

Day & fraction.	Arnold 2111.	Daily Rate.	Morice 201.	Daily Rate.
July 29. 875	− 2′ 9″ 70		− 41″ 21	
Aug. 1. 504	− 2 22 53	− 4″ 89	− 15 41	− 9″ 81

By interpolating between two successive moments at which the difference from the mean time of the one place is known, we can now find the difference from the mean time of that place in the same moment in which the difference of the Chronometer from the mean time of the other place was ascertained by actual observation, and thus determine the difference of longitude between the two places. In this manner we find by the three combinations of which the observations admit, the following results.

		DIFFERENCE OF LONGITUDE.		
		True Intervals in mean time.	Between the two Stations.	
MEAN TIME OF		Days.	Arnold 2111.	Morice 201.
Mr. Thompson's Monument No. 1, July 28,	004			
		1.869		
Station near the Rat Portage, July 29,	875		2′ 20″ 59	2′ 21″ 07
		1.329		
Mr. Thompson's Monument No. 1, July 31,	202			
MEAN TIME OF				
Station near the Rat Portage, July 29,	875			
		1.329		
Mr. Thompson's Monument No. 1, July 31,	202		2 21 77	2 21 71
		1.300		
Station near the Rat Portage, Aug. 1,	504			
MEAN TIME OF				
Mr. Thompson's Monument No. 1, July 31,	202			
		1.300		
Station near the Rat Portage, Aug. 1,	504		2 22 95	2 21 85
		2.502		
Mr. Thompson's Monument No. 1, Aug. 4,	004			
Mean Result of each Chronometer, Mean of all Results.		-	2 21 77	2 21 54

Difference of Longitude between Mr. Thompson's Monument and the Station near the Rat Portage, — 2′ 21″ 65

Mr. Thompson's Monument No. 1 is not the most northwest point in that vicinity. The bay on which it is placed extends about a mile farther, and terminates in a small pond which is free from rushes, and not fed by any considerable brook. Beyond this point, there is a swamp, which no doubt is part of the lake in the spring and fall of the year; but I have considered as the termination of the lake, in the northwest direction, the extreme northwest point of the pond, which we reached by paddling, without any difficulty, in the loaded canoe.

The courses from Mr. Thompson's Monument No. 1 are as follow:

1. N. 56° W. 1565½ feet.
2. N. 6° W. 861½ feet.
3. N. 28° W. 615.4 feet.
4. N. 27° 10′ W. 595.4 feet.
5. N. 5° 10′ E. 1322½ feet.
6. N. 7° 45′ W. 493 feet.

From these courses and distances I find, supposing the variation of the needle to be 12° east, that this point is

0″ 90 (time) west and } of Mr. Thompson's Monument
48 33 (arc.) north } No. 1.

The latitude of this point is therefore - 49° 23′ 54″ 81
And its longitude west of the Rat Portage station, in time, - - - - - - 2 22 55
or 35″ 38″ 25 = 35′ 6375.

Meridional Parts for various Latitudes, near those of the Stations.

Latitudes.			Meridional Parts.	Latitudes.			Meridional Parts.
49°	22′	50″	3417.′019	49°	45′	40″	3452.′230
	23	0	3417. 275			50	3452. 488
		10	3417. 532		46	0	3452. 745
		20	3417. 788			10	3453. 003
		30	3418. 043			20	3453. 261
		40	3418. 300			30	3453. 519
	24	50	3418. 555			40	3453. 778
		0	3418. 812			50	3454. 036
		10	3419. 068		47	0	3454. 293
		20	3419. 324				

Meridional Parts of the Latitudes of the Stations.

Meridional part for the latitude of Mr. Thompson's Monument No. 1, - - - = 3417′ 441
Meridional part for the latitude of the most northwest point of the Lake of the Woods in the vicinity of Mr. Thompson's Monument No. 1, - - - - - = 3418 679
Meridional part for the station near the Rat Portage, - - - - - - 3452 656

Comparison of the different Stations.

Rat Portage Station and Thompson's Monument No. 1.

Difference of meridional parts.	*Difference of longitude.*
35′ 215	35′ 4125

Rat Portage Station, and most northwest point of the Lake of the Woods, in the vicinity of Mr. Thompson's Monument No. 1.

Difference of meridional parts.	*Difference of longitude.*
33′ 977	35′ 6375

It is therefore evident, that, according to the observations, Mr. Thompson's Monument No. 1, is a little more northwest than the station near the Rat Portage; but the most northwestern point of the lake in the vicinity of Mr. Thompson's Monument No. 1, is considerably more northwest than the station near the Rat Portage, and is, therefore, agreeably to the principles explained in this report, the most northwestern point of the Lake of the Woods.

With regard to the accuracy of the observations, I beg to remark—1. That the angles by which the latitudes are determined are all read off on the same, or nearly the same, divisions of the sextant, and that, consequently, all errors, which the sextant may have, are common to both latitudes, and do not affect the difference of latitude on which the result chiefly depends. 2. The difference of longitude being correct, it would require an error of more than one minute in one of the latitudes, or an error of more than thirty seconds and of contrary sign in each, to change the result derived from the observations. 3. The agreement of the two chronometers shows, that the difference of longitude cannot be far from the truth. 4. If there should be any doubt respecting the observations for time depending on single altitudes, on account of the possible errors of the instrument, it is to be observed that these errors would be too small to affect the result, and that nearly the same difference of longitude may be derived from the equal altitudes only which are not liable to the same objection.

The sun's declination, and the equation of time, have been calculated from the Nautical Almanack, on the supposition of the longitude of the station near the Rat Portage being 94° 39′ west of the Royal Observatory at Greenwich, which would give the longitude of the most northwestern point of the Lake of the Woods, in the vicinity of Mr. Thompson's Monument No. 1, 95° 14′ 38″ west of the same place.

Note.—Mr. Tiarks made oath in New-York, Nov. 18th, 1825, before Judge Irving, to the truth and correctness (to the best of his knowledge) of the above report.

Art. VI.—*On the Vitality of Matter.*

(Communicated for this Journal.)

The mystery of life, or the cause of sensation and voluntary motion, has been a subject of the deepest interest in all ages of the world. The curious and the learned have instituted the most diligent inquiries to discover whether the hidden principle is an emanation from the divinity, or a supernatural gift; or whether it resides in the organized structure, by some particular disposition and consent of parts; or whether each particle possesses inherent powers of life in its separate state, and thus spontaneously arises from decaying forms to engage in new scenes of activity.

Within a few years, from some investigations with the microscope, a theory has arisen, which maintains that this mysterious principle is inherent in the elementary forms of matter, and that they assume new shapes, and revive in their primitive activity, whenever death changes their aspects.

These doctrines, adopted in their full extent, restore the dogmas of the metempsychosis, and the chances of Democritus, and, by vulgar induction, end in atheism. Without the dignity of that system of which Epicurus, Lucretius, Pliny and Lucian were disciples, they fall into the materialism of Leibnitz, who considers "each monad or atom possessed of perception and appetite. This appetency produces an internal principle of alteration—hence the sympathies and affinities, the combinations and the forms of bodies."

The Epicurean theory, although it deemed matter eternal and insensate, and that its particles, by jostling forever, had at length adhered in masses, ultimately forming the world itself, inhabited by animals, and clothed with vegetation; yet, it taught that it was operated upon by an immaterial divinity, and that life was imparted by a divine invisible power, who ruled over all.

In later times, Sir Isaac Newton built a noble superstructure upon the principle asserted in the Mosaic account of the creation—that all things were made by an omnipotent, immaterial, intelligent being; that he established those immutable laws by which the universe is regulated and governed; and that he imparted animation to creatures by bestowing upon them the breath of life.

But Dr. H. M. Edwards, an English physician in Paris, and Dumas, Dutrochet, Prevost and others, have ascertained to their own satisfaction, by some elaborate discoveries with the microscope, that the elementary, organic, constituent parts of animal and vegetable bodies, inherently and independently possess the vital principle; that spirit of life, which has hitherto been veiled in mystery. Edwards describes the animal body as "built of animalcules, as a pyramid is built of bricks," being a congeries of countless millions of organized units, "each capable of living in a separate state, and perhaps exercising the functions of individual life, while incorporated in one being. He teaches that these monads or globules, being of the $\frac{1}{8000}$ part of an inch in diameter, by one arrangement form the various tissues and fibres of the animal structure; and by another arrangement, spring up in the glowing colours and varieties of vegetable life, and that when death passes upon them, and decomposition separates the parts, elements which were before parts of some animal, become vegetables, or if it so may chance, vegetable atoms awake to life as animals.

These inferences rest on the following experiments.

Dr. Edwards examined a piece of animal substance macerated in water, and immediately perceived a number of white vesicles moving about with great rapidity. These he considered to be animalcules of the tribe monades. He observed that these monads lost all power of motion when the water evaporated. "If water were added *immediately* after the cessation of motion, they again began to move, but if allowed to remain dry for a short time, they never recovered the faculty of locomotion." He also observed, that "whenever they adhered to the sides of the glass, they exhibited every appearance of vegetable life."*

The same experimenter macerated a leaf of the horse-chesnut, and "as soon as the particles became detached from the margin of the leaf, they were seen to put themselves in motion;" thus showing that when the tissue of plants is decomposed in water, its component organic parts possess independent life, and spontaneous motion.

Another example, though not included in those mentioned by Dr. Edwards, is still more surprising, as it would suggest that the degree of heat which destroys life in visible objects, had the effect, while life was in its invisible state, to aid in its development. "A potatoe was boiled in water until it

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* Westminster Review, No. 13, Jan. 1827.

became of a mealy consistence. It was closely covered in a glass vessel, and a drop of the water was examined twenty-four hours after, when it exhibited innumerable animalcules in great activity."

From these examples, they conclude that sensation and voluntary motion reside in matter; that however minutely the parts are dissociated, they still possess a principle of vitality; "that death does not destroy their susceptibility; and that life and matter are coexistent, and from everlasting to everlasting."

These data, and the inferences deduced from them, being at variance with those visible facts, and those unerring, invariably recurring rules called the laws of nature, an inquiry respecting them is justified—

I. Whether there is not a fallacy in those appearances which are assumed as first principles?
II. Whether life exists in brute matter? And
III. Whether inert matter, or particles specifically animal or vegetable, can spring to life, in natures remote from, and opposite to, their own origin?

I. *Is there not a fallacy in those appearances which are assumed as first principles?*

Microscopic discoveries are peculiarly liable to error. They require great acuteness and accuracy of sight, and the contradictory conclusions made by the most exact observers with the microscope, render it of doubtful validity. As it would be unfortunate to build a principle in physiology upon an optical illusion, those appearances which have been adduced should be received with great caution, because, if the first point is wrong, every succeeding step must be erroneous, and all further reasoning upon it would be confirming the deception.

A fallacy may therefore be suspected in those appearances which were considered as voluntary motions. It is worthy of remark, that the monads were viewed through the refracting medium of water, and that many of the fibres retained their thread shaped forms, while others, still farther divided, were reduced to points or globules. Being so attenuated as to be scarcely visible, the progress of decomposition producing a further separation of parts, and moving them by chemical action, might easily cheat the senses with the appearance of animation. While the motions accompanying a chemical process are visible to our unassisted sight, they excite no surprise. A piece of sugar rises and falls in a glass of water, bubbles agitate the mass with motions which appear to be inherent, but these phenomena are not suspected of bearing any relation to life. The motions of the eye stone in a plate of vinegar have been attributed to animal life, but as it is a calcareous stone, the motions are obviously referable to the action of the acid upon it, which disengaging a gas, impels it mechanically from side to side. Gaseous particles, disengaged or acquired at the precise point of time when those macerated materials were under examination, by effecting a moving impulse upon them, aided by the refraction of the water, and the minuteness of the particles, might produce a resemblance to life, although by no means a demonstration that they possess vitality. Further proof is unattainable, as the subject eludes further inspection.

We are therefore warranted in doubting the correctness of the inference, that the motions discovered by the microscope were attributable to animal life: and we are justified in believing that the senses were deluded by appearances resembling life which were not life; inasmuch as the circumstances under which they were detected, render the evidence of the senses imperfect; and as the conclusions drawn from the analysis are unsupported by analogy throughout the visible creation.

But if no doubt rested upon the fidelity or capacity of the human senses in this inquiry, and if it were granted that man with his excellent perfections, and the oak with its duration and grandeur, are composed of the identical particles which form the ignoble reptile, and the poisonous weed; yet we are assailed at this point of the inquiry with the

II.'d question, *Whether life exists in brute matter?*

If animation were inherent in matter, and the presence of watei were to awaken the principle, why should it leave the monads as soon as it is withdrawn? and why do they not revive on its reapplication? Mr. Edwards expressly states that "they never recover the faculty of locomotion, unless the water, after evaporation, is immediately restored." It is a contradiction to say, *that life is inherent in matter*, when, by changing its circumstances, it becomes deprived of it, and *cannot regain it.* What is that but death in its common acceptation? The term death implies a change from the power of acting to total inactivity. It implies an utter and irrecoverable extinguishment of sensation, and the faculty of motion. Inertness expresses the state of matter without life, and without any innate principle of revivification.

If the water were not withdrawn, would those particles of matter remain stationary, or would they increase in dimensions; or would they change into other living beings; or form other and unknown combinations? Whatever their shape or location, whether they remain units forever, or experience transformation, *if they are indued with an inherent living spirit*, they must be immortal. A thing possessing an innate principle of vitality cannot be dispossessed of it, unless it is annihilated. If annihilation can dispossess a material monad of existence, the same principle may apply to masses of matter, and the balance of the globe be destroyed by its operation. The order being disturbed which rules the planets in their spheres, and establishes the symmetry of the universe, the whole might rush into chaos, or evanish into nonentity.

But to return to the vitality of material elements. Animal and vegetable matter having been interred in the earth, or decomposed upon its surface, for nearly six thousand years, if the particles were immortal in the animalcular form, the grave would not secure them, and the earth by their accumulation would be heaving and rolling under our feet. There is abundant evidence, however, that bodies continue in the grave long after their inhumation. A single instance is sufficient for the argument. The remains of Charles I. of England were discovered a few years since, after having been interred two hundred years. They were found in their natural state, so far as to be readily identified, and exhibited every appearance of inert matter, resolved and resolving into elementary dust.

The microscopic theorists having conducted us to the lowest gradation of existence, remark that "physiologists can carry analysis no farther, except to convert the substance into gases by distillation." If so, where is the vital principle then? Can distillation extinguish that principle which resisted death and all the previous stages of decomposition? If "life and matter are coexistent, and from everlasting to everlasting," it is absurd to say that distillation, or any other material agency, can separate them, or destroy that life; and there appears no other alternative but to presume it to be still existing invisible among those aerial vapours to which it was driven by this mode of analysis, waiting for some casual chance to be united to a new shape, and enabled to pursue some new career of being.

From these premises the conclusion is irresistible, that after experiencing the changes of death and decomposition, material atoms, possessing inherent vitality, *are transformed into some unknown shape of moving life*, which establishes the doctrine of the metempsychosis without qualification. Those who affirm that when a living being dies, it only changes its form, will easily believe that men may arise unseen from their sepulchres to people the fields and forests;* or, indulging the poetry of feeling, they may fancy their departed friends returning among them as singing birds or blooming flowers, or as waving trees overshadowing their dwellings.†

But our later philosophers are not as courteous as Pythagoras and Ovid, nor as pious as Plato and Epicurus. They make us descend to the most degraded state, and from the decomposing remains of our animal nature they see clouds of loathsome insects floating on the air, winged with pestilence and death. They do not indulge in the fine imaginings of those heathen; the former of whom maintained that the spirits of human beings who led virtuous lives were changed into seraphs, fairies, and heroes; trees, flowers, and fountains: or with the latter, that the gift of life was *bestowed* by a divine almighty power; or with Plato, that it remigrates to the divinity from whence it originated, after leaving its transitory abode in this world.

In assuming that "life and matter are coexistent," identified, indivisible, and eternal, it is also asserted, "that it is perpetually living, dying, reviving, and recombining in new shapes and modes of existence."‡ If so, then is not the boast of the atheist established, and accountability and moral obligation destroyed?

Based upon this hypothesis is the theory of the Gordius Aquaticus, or horse hair snake; and as this is the boldest example, in illustration of this system of physiology, it is selected as a test for the

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* Pythagoras. † Ovid. ‡ Mason Good.

III.'d inquiry, *Whether inert particles of matter spring to life in forms and natures remote from, and opposite to, their own previous state of existence?*

It is imagined that myriads of monads congregate upon a hair immersed in water; that having in itself a vital principle, it assimilates with these extraneous visitants, and they with each other, until this admixture of fortuitous materials becomes a living being; that gradually "a complete animal is developed, the root of the hair assuming the shape and character of the head, with eyes and mouth." It is not difficult to conceive that a hair, by being placed in water, an element where millions of ephemera occasionally reside, should be covered with them so as to make an entire surface, and that from its elasticity their motions should impart sinuosity through its whole length, and that it should be found writhing and turning like an organized, animated being, although no more endowed with animal life than the limb of a tree, which sways backward or forward, in compliance with the impulse of a boy upon its branches. But for a mass so heterogeneous, and so far removed from all the habits and laws which are invariable concomitants of animal life in every known instance, to obtain a head to guide its voluntary motions; a mouth whereby to receive its sustenance; itself affording aliment to a congeries of insects, creatures of a distinct and separate genus; to become identified with them, and spring to independent existence, and be itself the individual in which they lose their identity; is too monstrous and absurd to admit of belief. It is confounding the distinctions which divide animals from each other, and from brute matter to affirm, that an integral part of a quadruped, having been reduced to utter inertness, should revivify itself, acquiring a head with its curious and complex organization to control its movements, and from the identity of a land animal to become a water serpent. If it be possible for one quadruped to produce snakes, another may; and, if snakes, why not other and more monstrous forms of existence?

Pursuing the analogy, why are not cemeteries and fields of battle overgrown with night-shade and hellebore, and peopled with gorgons and hydras? But it is argued that a butterfly arising from a worm is analagous to the presumed metamorphosis of the gordius aquaticus. The example is not a parallel one. The butterfly preserves its identity through all its changes; it is the same specific and entire being; and its race is continued subject to the same invariable laws. It is not a casual association of atoms, at one time part of a horse, at another, part of a serpent. If the chrysalis were attached to the side of a piece of tortoise shell, or other substance similar to hair, and on bursting its cerements, the shell should become its head or its painted wings, then the case would be parallel to the horse-hair snake.

It is further stated, as will be kept in mind, that vegetables after death arise with the locomotion of animals. Also that the monads of animal remains revive in vegetables, or animals, as chances occur. The atoms of a chesnut leaf were animals while in the water, but upon being dried upon the sides of the glass, became vegetables, with appropriate forms and colours: and finally, that a drop of water in which a vegetable (potatoe) had been *boiled*, discovered innumerable atoms in great activity. This is an anomaly in the experience of the whole world, boiling heat being destructive of life; but in this instance the vital principle is stated to have triumphed over its vegetable origin—over death—over the destruction of fire—and, surpassing even the fabled Phenix, to have awaked to life and animation.

The examination of this subject has been extended far beyond my original design; but on a review of the whole argument it appears that the following are undeniable positions:

1st. That life is not inherent in matter, because it is in proof that the material elements of animal and vegetable remains continue insensate for ages after death—that the presumed fact of their revivification rests upon the slender evidence of microscopic observations—that the phenomena adduced to establish it were probably optical illusions, occasioned by chemical action and disturbance—or were owing to some other cause than material innate vitality.

2d. That the order which prevails throughout the visible creation proves that all things are governed by immutable laws, which have been the same from the beginning, and which forbid the revolting idea that inert matter springs to life in odious and degraded shapes, remote from its generic origin; and that animals cannot change to vegetables, nor vegetables to animals; nor animals to others of opposite genera; else

"Man himself might spring from ocean,
Prone down the skies the bellowing herds might bound,
Or from promiscuous earth the finny race and feathery tribes ascend."*

If these inferences are correct, it follows, that in all the complicated series of existence, and in all the changes which chemical and other agents produce upon matter, the hidden principle of life has never been revealed.

Even galvanism, which has almost imposed upon the credulity of science a suspicion that it possesses the power of restoring the vital principle after it has left the clay, has been found to exert only a mechanical action upon the inanimate subject; while it electrifies the muscles and limbs, and produces motion resembling life, yet life is not there, and the hideous distortions it occasions, as if in mockery of human wisdom, leave the body an example of the insufficiency of matter to revivify itself, or to furnish any clue to the mystery of its animation.

Vegetable life is equally hidden from human sight. A grain of sand cannot become a tree, though with other grains and other combinations it sustains the tree in verdure and beauty. If men could obtain a knowledge of the mystery of life, they might restore it when taken away—the fabulous systems of the poets might return as realities—groves might wave in sudden luxuriance over the dreariest deserts—and multitudes arise, as if by the magician's impulse, where solitude and silence have hitherto held undisputed dominion.†

Art. VII.—*On the Zodiacal Light.*

(Communicated by David Leslie, New-York, March, 1828.)

The Zodiacal light, generally ascribed to the sun's atmosphere, is nothing more than those beams of light, seen at times to issue from the sun through the interstices of dense

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* Lucretius.

† The author appears not to have adverted to the fact that innumerable animalculae are discovered by the microscope in and upon almost every thing, and that therefore the apparent animation of inert matter may arise from the adherence of these animalcules, whose origin is doubtless by the regular although singular processes of life.—*Ed.*

clouds, when that luminary is near the horizon, and are called by seamen, *shrouds* and *backstays*, from their resemblance to those appurtenances of ships. These beams, which by the laws of perspective, appear to diverge from the sun, are, in fact, parallel, and when seen of considerable length, they of course appear arcs of great circles. When the sun is in, or a little below the horizon, they are often seen to converge to a point diametrically opposite to the sun, and have no relation to the sun's equator. The beams are seldom seen far from the vanishing point. I have seen them almost every day, in certain places, within the tropics. They are however often very faint, and can be seen only by a practiced eye, and as in looking at a celestial nebula or the tail of a comet, are best seen with the eyes partly closed, or by looking a little to one side of the object. These beams are produced in the same manner as those in a room where there is smoke or dust, and the sun shining in through the window. The vanishing point of the solar beams is seen in the sea, when transparent and smooth, and the sun shining at least 60° or 70° above the horizon. Then by looking over a vessel's side, opposite to the sun, the spectator will see around the shadow of his *own* head, only a kind of corona.* The same phenomenon may likewise be seen in a stratum of fog when the sun and observer are in certain positions, as when seen

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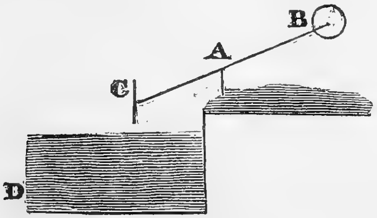
* This has been called the *Apotheosis* of travellers. (V. Malte Brun.) The appearance is caused either by rain, fog, or spray, on the same principles as the common rainbow. A line drawn from the centre of the sun passing through the eye of the spectator who has his back to the sun, passes through the centre of the bow. Consequently, if the spectator be elevated above the horizon, as when on a high mountain, he may see the entire bow encircling the head of his shadow.



Let A be a spectator standing on the brow of a high mountain ; let B represent the sun; then C will be the bow, both parts of which will be visible to the spectator; and being projected on the subjacent plain, or upon the clouds, along with his shadow, it will appear to encircle his head like a corona.

What Mr. Leslie calls zodiacal light are phenomena included under the multiform appearances of *halos*. La Place has an article on "Zodiacal light," but limits it to a peculiar appearance sometimes from about the vernal equinox.—*La Place's System of the World.*

by the Spanish Mathematicians while triangulating the Andes. It has also been seen by some Aeronauts of late years. I do not remember to have seen the Zodiacal light in high latitudes, but I think that Parry states that he saw something of the kind at Melville Island, in the point of the heavens opposite to the sun, before he reappeared above the horizon, in the spring.

While on optical phenomena, I must mention the following as noted in my journal in the Pacific.

"Ship Jupiter, July 13th, 1824, Lat. 14° North, Lon. 139° W. This afternoon I was gratified with a most beautiful and unusual sight, viz. part of four distinct concentric rainbows, all united to each other. The principal or outer bow made the usual angle with the sun, and was the broadest; the others diminished in size and brightness, but the prismatic colors were distinctly seen in each, and were all in the same order. The secondary bow, often seen at a distance from the primary, with colors reversed, was not seen. The bow was complete to the horizon, but the compound part was not above 20° in length. The compound part did not appear to be broader than that which was single. The sun was about 12° above the western horizon, shining through the interstices of a very dense broken cloud; each aperture appeared almost as bright as a sun,* and which I supposed produced the different bows. The wind was from the direction of the bows, and in a few minutes afterwards a shower of very fine rain fell, and the bows disappeared."

P. S. General Humphreys told me that on a morning of a 4th of July, in Connecticut, about sunrising, he saw to the westward, and opposite to the sun, beams of light radiating from a point, and those who had never seen or heard of such a thing before, considered its appearance on that day as ominous. This was no doubt the Zodiacal light.

Art. VIII.—*Remarks upon Bleaching.*

Communicated for this Journal.

The improvements made in the art of Bleaching during the last half century, have in some measure conquered the

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* Those I think must be the mock suns mentioned in the books,—I have never seen any other.

prejudices inseperable from long established habits, and practical men though strongly wedded to their own methods of working, and sufficiently jealous of projected improvements, have yielded reluctantly to a conviction of their utility. It is presumed that the usual method of chemical bleaching as now practised both in Europe, and the United States of America is too well known, to require a particular description. In that method, there appears to me to be a fundamental error in the alternate use of hot and cold liquors. It is evident that a heated solution of alkali opens and expands the fibres of linen submitted to its action, and thus affords an opportunity for the alkali to act upon its coloring matter, and to increase its solubility. But the second step in the ordinary process of bleaching, counteracts the first. The linen is taken *hot* from the bucking tub, and immediately thrown into *cold water*, for the purpose of being washed. The fibres of linen collapse ; the coloring matter is condensed, and its affinity for the linen is restored, which is manifestly the reverse of the object intended to be gained by the process.—If the rinsing water be of the same temperature as the alkaline liquor, this re-action is prevented.

2dly. From this washing in cold water, the linen, after having been bucked a sufficient number of times, and exposed for months to the air in the fields, comes, in due course of time, to its second stage of operation.

The linen in large quantities, is immersed in vats of cold chloride of lime, in a quiescent state, and the bleaching properties of the liquor act upon it imperfectly and unequally, in consequence of the dense mass of linen, and the frigidity of the medium through which it has to act.

If the linen were put into the bleaching liquor moderately warmed, confined so as to prevent the escape of gaseous vapours, and then set into regular and constant motion, these objections would be obviated ; the effect of the warm liquor would be uniform and active, which can never be the fact while it is cold, and in a state of rest.

What I have remarked concerning the manner of using alkaline and chloruretted liquors, applies with equal truth to the use of acidulated water in the third stage of bleaching.

3dly. The third most important point to be considered in the process of bleaching, is the degree of heat to which the linen is subjected.

Bleachers are generally sensible of the advantages of heat, and various contrivances have been adopted to apply *steam heat* to the purposes of bleaching. But I am not aware that any one has attempted to bring his goods into *action* in steam heat *under pressure.* Nor do I know that there has ever been any mechanical invention brought into practice, by which it could be done, until my machine was constructed. The French Bleachers have taken much pains to use an alkaline solution at a temperature above boiling heat, but without success. They seem to have a correct idea of the probable effect of increments of heat above that degree, but failed in their attempts to reach it, through the imperfection of their mechanical inventions.* But I can find no evidence of their ever having conceived an idea of the advantages likely to result from the combined action of *heat* and motion.

Unless the steam is brought to act *under pressure* it is evident that no material benefit is gained by steaming instead of boiling—often the reverse, because the heat will never exceed, and the moment it is exposed to the atmospheric air will fall below 212° Fahrenheit or boiling heat. But if the steam is *confined*, it is easy to raise its heat to 230° and then the effect upon the linen shows, in the most unequivocal manner, the advantages of augmented heat in bleaching. This effect is not only more strikingly obvious, but is singularly beautiful, when the goods are put in motion, and the degree of bleaching is rendered perfectly uniform.

There can be no danger, as some have apprehended, of injuring the linen by excessive steam heat, because the scorching heat of steam is 520° Fah.—a pressure of fifty atmospheres or seven hundred and thirty five pounds upon a square inch —a pressure which no ordinary steam apparatus will resist.

Steam heat at 350°. thermometical measurement, will so far soften soldering as to cause it to yield to the pressure, and the steam pipes will burst. These are facts which I state as the result of my own repeated experiments, in which I cannot be materially mistaken, and therefore I feel justified in saying, that it is not possible with any ordinary working apparatus, to carry steam to so high a temperature as to injure any goods submitted to its action. By giving motion to the linen, under the reciprocal action of steam heat, under pressure, and alkaline liquor, the effect is not only more powerful, than it can be by bucking, but, as already hinted,

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* Vide Berthollet on Dying.

it is more uniform. Every part of the cloth is equally exposed to the operation, and the coloring matter detached from the cloth, floats in the liquor below.

This appears to me to determine the question which some have raised, whether the coloring matter of linen is actually detached from the cloth, or is bleached upon it without being detached? When we find that the loss of weight, in the various methods of bleaching ranges from twenty to thirty per cent.—and when we find the coloring matter suspended in the liquor, and reducible by evaporation to a mucus, it seems to me that there can be no doubt that the coloring matter is removed—at any rate a large proportion of it. The repeated experiments which I have made upon a considerable scale in bleaching, clearly demonstrate the utility of combining heat and motion. The action is direct, immediate, and uniform. The strong affinity which unites the coloring, the glutinous and the oleaginous matter to the fibres of the linen is weakened and rapidly overcome, and no opportunity is afforded for their subsequent combination.

By this method I have bleached Scotch drills in twelve hours, and Manchester cotton shirtings in four.* There will be no occasion to croft cotton goods, but linens receive a clearer and more brilliant white by exposure upon the grass for a few days. JUNIUS SMITH.

Liverpool, Jan. 15*th*, 1828.

P. S. I have omitted to notice, that the saving in alkali by this method of bleaching, compared with the usual consumption by the English, Scotch and Irish Bleachers, is about twenty-five per cent.

ART. IX.—*Biographical Notice of Alexander Volta.*

(Translated for this Journal by Prof. John Griscom.)

BEFORE the great discovery which bears his name, and which has immortalized him, Volta had devoted himself to Electricity, and Chemistry. The researches of Muschenbroeck, greatly interested him, and it was not long after this, that his memoir on the attractive force of the electric fluid, appeared. At a later period, he applied himself to perfecting the philosophical instruments for measuring electricity,

* Specimens of these articles perfectly bleached by Mr. Smith's process are in our hands.—ED.

and to the invention of new ones; the Electroscopes of Cavallo, and of De Saussure, obtained in his hands, the greatest exactness; the Electrophorus, and the condenser, owed their origin to him. This last apparatus, especially, founded on the true principles of electricity, of which it is the consequence, is to that science, what the microscope is to natural history, in permitting us to appreciate the quantities of electricity, which by their feeble effects, would have entirely escaped the means formerly known.

The condenser was to shew, at a later period the important part, which the electric agent held in nature and the great number of phenomena which produce it, and finally it was to become, to Volta himself, the basis of his grand discovery, the means of shewing that there is a development of electricity on the contact of two metals.

It was in electricity that Volta found an explanation of the greater number of meteorological phenomena.

His hypothesis of the formation of hail, is ingenious, and his observations upon the periodical return of clouds, are not without interest; but in general, we must distinguish throughout this subject, the theories of the author, from the numerous, and curious facts, with which he has enriched the science of meteorology, still so imperfect.

Let us turn our attention, for a moment to the labours of Volta, relative to chemistry; labours, which are worthy of our attention, from their results, and from the progress of invention which distinguished them. It was he who discovered the inflammable gas of marshes, and who furnished an explanation, the consequence of the former, of the wandering fires, and of those igneous phenomena, which are sometimes produced upon the surface of the ground. He has shewn that they result from the combustion of this gas, by means of electricity.

It was on the occasion of the discovery of an inflammable spring, which was observed to issue from a fountain in 1776, that he suspected the true cause of this phenomenon and of some other similar ones and which he attributed, not to a circumstance purely local, but to the formation of a gas by the fermentation of vegetable and animal substances in contact with water.

Thus he shewed that wherever there was muddy ground or stagnant water, on stirring the bottom, bubbles of this gas would arise; which gas was proto-carburetted hydrogen.

He explained in the same manner, the cause of the burning soils of Barigazin, of the burning fountain of Dauphiny, of the igneous phenomena of Petramala, of Villeja, &c.; the inspection of places every where proved the correctness of his explanation, which had besides the positive merit of pointing out the imperfectly known cause of these wandering fires, and the advantage of shewing that this phenomenon was not owing, as was supposed, to the presence of petroleum or bitumen, in the places where it was manifested.

Volta was led by the observations to which we have just alluded, to the discovery of the electrical pistol, in which, by means of an electric spark, the sudden combustion of hydrogen, produces a loud explosion. It is this property of electricity, of setting fire to inflammable gases, which, combined with another discovery of Volta, that of the electrophorus, gave birth to the hydrogen gas lamp. It is also to the same property, that we are indebted for the most exact mode of analyzing gases, particularly the eudiometer, invented by Volta himself. This instrument, the use of which, is to shew the proportion of oxygen contained in a certain quantity of atmospheric air, depends on different principles, all of which proceed from chemical affinities. The mode proposed by Volta, and which has been acknowledged by Humbolt and Gay Lussac, to be preferable to all others, consists in mingling with the given quantity of atmospheric air, a quantity of hydrogen more than double the quantity of oxygen, which is known to exist in the purest air, to determine afterwards, by an electric spark, the combination of the two gases, and consequently the formation of water, and to take one third of the total diminution of the mixture, which is found to be the expression of the given quantity of oxygen sought.

It remains for us to speak of that discovery of Volta, which has contributed most to his fame, viz. the new method of producing electricity, which is called by his name, and which will always remain a monument of the genius of this learned man, to whom it owes its origin.

Galvani, being engaged in some anatomical experiments, perceived that two heterogeneous metals, connected by the intervention of a frog, suitably prepared, produced in the muscles of this animal, a sudden commotion, similar to an electric shock. This learned gentleman and some other philosophers, struck with this phenomenon, endeavored to explain it by a fluid sui generis, which they called animal electricity, and which they supposed to be put in action in the experiment just named. Volta's opinion was widely different from that of the authors of this hypothesis. He advanced the idea, that this fluid was nothing more than common electricity developed by the contact of two metals, and that the frog only acted the part of a conductor and electroscope. This simple and natural explanation met with many objections. Galvani and the other philosophers alleged that it was not necessary to make use of two different metals, and that the contact of two similar metals, or even that of the muscles and nerves of the frog, was sufficent to produce the shock, which, it is true was much weaker. Volta replied that these results proceded from this, that the metals were not perfectly the same, and that the nerves and muscles might also, as heterogeneous substances, produce electricity by their contact. Volta must be admired for the indefatigable perseverance with which he endeavored to prove the truth of his explanation, and of the general principle, that two heterogeneous bodies in contact are in two different electrical states; he was not discouraged either by difficulty of execution, or by the ceaseless attacks which were directed against him by philosophers rendered jealous by not having been able to discover a truth which was directly before their eyes. He succeeded in producing electricity simply by the contact of two metals, without the aid of a frog; he shewed by means of his condenser, that the agent produced in this manner, possessed all the properties of common electricity; he replied victoriously to his adversaries, who dared no longer to oppose him, in making to the scientific world the invaluable gift of the apparatus known by the name of the voltaic pile.

Volta was led to the construction of his pile by the distinction which he established, between electro-motive bodies, such as the metals, and bodies, which are not electromotive, or only in a very low degree, but which serve only as conductors, such as fluids.

Having discovered that the contact of two different metals, called a pair or a voltaic element, produces a certain quantity of electricity, he was enabled to increase this quantity, by the union of several of these elements to one another, by means of one of those conductors such as water holding in solution a salt or an acid.

It is the union of all these couples, which is called the voltaic pile, and which forms an apparatus capable of producing electricity with a force to which no one has been able to find a limit, since there is none in the size and number of the elements which can be thus brought together.

Volta's theory of the pile, in which he attributes the electricity produced, solely to the contact; regarding liquids as acting no other part than conductors, has been strongly attacked, particularly by the English chemists. We will not say with the author of the notice, that it may be rigorously demonstrated that the oxidation occasioned by the liquid, is only the effect, and not the cause of the electrical agent; we believe on the contrary, that if it is true, as Volta has proved it, that the contact of the metals is necessary for the production of this electricity, it is not less true also, that the chemical action of the acids, or of the saline solutions upon the metallic plates contributes much to the effect. But we must also admit that the theory of the pile is far from being perfect, and that we cannot hope to have a more satisfactory one until the numerous and various effects of this admirable instrument are better understood.

Volta has shewn, as we have said before, that the agent produced by the contact of two different bodies, possesses all the properties of electricity, he shewed also, that this agent accumulated in a much greater quantity at the two poles or extremities of the pile, may produce all the effects of the electricity of machines, such as attraction and repulsion, charging a Leyden bottle, &c. and in a word, it is known that the accumulation at one of the poles is called *negative*, from negative or resinous electricity, and at the other pole, it is called *positive*, from positive or vitreous electricity.

The discovery of the pile is important, not only because it offers to us a new class of phenomena, and because it furnishes a new mode of producing electricity;—it is especially important because it presents electricity to us under a form until then unknown, and which renders this agent capable of producing effects, some of which could not before be obtained by the aid of common machines, and others were not so strong and were always instantaneous, or not continual. We allude to the phenomena which the pile presents, in uniting the two poles by a conductor, and permitting the two accumulated electricities to reunite, and form a current, which is found to be continual, on account of the faculty which the apparatus possesses, of producing the electrical agent as fast as it is expended.

It may seem to be a departure from the subject of this article to describe these phenomena, but we think with the Italian author, that to become duly sensible of the value of the great discovery of Volta, it will be necessary to present some of the consequences which flow from it, and to show how fruitful in important results it has been in the hands of philosophers. It is not an exposition, nor even a complete enumeration of the effects of the pile that we pretend here to make; it is only some of the more conspicuous facts which owe their origin to this apparatus, which we wish to dwell upon.

In following the author of the biographical notice, we shall recall the curious experiments of Erman, on the property which certain bodies possess, of conducting only one or the other of the electricities of the pile, and the distinction which it draws between unipolar and bipolar conductors; the different forms given to the voltaic apparatus by Volta himself, by Wollaston,* Pepys, Children, Accum, &c.; the dry piles made by De Luc and Zamboni; the wet piles constructed by Davy with other substances besides metals, &c. All these details belong more properly to the theory than to the effects of the pile; as we shall partly complete them by citing with the author, the labors of Marianini relative to the electromotive faculty of certain substances, and to the influence of temperature and other circumstances, either upon this faculty or upon conductibility; and lastly in adverting to the researches of Prof. A. De La Rive upon the electric currents disseminated in fluids, and the experiments in which he has laid hold of several remarkable analogies between electricity in this state, and the properties of light and of radiant caloric.

The services which the discovery of the pile has rendered to philosophy, are neither less important, nor less rich in consequences than those which it has rendered to chemistry. Not only has voltaic electricity furnished a new and much more powerful mode of producing heat and light, than the ancient, but it has given birth to a new class of phenomena, of a kind, then quite unknown to science.

Philosophers remarked not long after Volta had put the pile into their hands, that conductors placed between the

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* Dr. Hare is certainly entitled to be mentioned in this list.—Ed.

poles, would be very strongly heated, particularly metallic wire, and even platina wire would melt and burn. The most conspicuous characteristic of this kind of ignition, independent of its intensity, is, that it is continual, and has no resemblance to combustion, since it acts in a vacuum, or in gases which are not supporters of combustion, such as azote, and carbonic acid, as well as in air. In vain have philosophers every where sought to study these effects in varying and reproducing them under a thousand forms; as yet, no satisfactory explanation has been given. They have only increased the number of experiments, and here we ought not to forget to mention that of Davy, one of the most remarkable in experimental philosophy; we mean the brilliant jet of light that this able chemist has produced between two pieces of carbon, in connecting them with each pole of the pile.

Ever since the earliest enquiries into the nature of electricity and magnetism, philosophers have suspected that an analogy existed between these two agents, but this, until 1820, had been purely hypothetical.

It was reserved for the voltaic apparatus to show by facts the truth of this analogy; it is to Oersted that we are indebted for having known how to prove this experimentally; he discovered the action which a conductor, uniting the two poles of the pile, exercises upon a magnetic needle.

If we have thus far adopted the order of ideas traced by the Italian author, without however subjecting ourselves to the necessity of following him step by step, and omitting nothing which he has said, or adding nothing to his exposition, we are now obliged to abandon him entirely. In fact, after having claimed the honor of the experiment of Oersted in favor of two of his fellow citizens, Mojon and Romagnesi, he satisfies himself with recalling the determination by Biot and Savart, of the law which governs the new action, and the very remarkable fact discovered by M. Arago, of the magnetism given to needles of steel by an exterior electric current. But by a forgetfulness which we cannot account for, the author does not mention the name of M. Ampere, of that philosopher, who may be justly called the creator of a new branch of physics, called electro dynamics; the history of the labors of this philosopher is the best homage that we can render to the memory of Volta, since they show of what great theoretical and experimental discoveries the pile has been the origin.

M. Ampere had for a long time meditated on this subject, and he appeared only to wait for a favorable opportunity, to give vent to the results of his meditations, when the discovery of Oersted suddenly appeared, he immediately availed himself of it, and by his labors, laid the foundation of a new science. Whatever may be the present and future opinion relative to the ingenious theory which this philosopher has sought to establish, the numerous facts by which he has enriched science, will always remain a monument of the services which he has rendered, and if some difficult minds should find his explanations insufficient, his hypotheses a little too bold, let them not forget a least, that abstractly from their intrinsic merit, it is these explanations, these suppositions which have given birth to numerous experimental discoveries.

The first step that M. Ampere made on electro-dynamics, was to discover, that, independently of the influence which the electric currents exercise upon the magnetic needle, they exert also an action upon one another, the law of which, he determined. He soon went farther; instead of imputing, as all other philosophers at first did, the influence which a conductor of voltaic electricity exercises upon a magnet, to a magnetism impressed into this conductor, by the current, he shewed with much sagacity that the magnet itself is nothing more than a union of electric currents, and that the action discovered by Oersted is only a more complicated case of the simple action of two currents upon one another. As a proof of the identity which he established between magnetism and electricity, M. Ampere shows that all phenomena relative to the action of magnets and currents, even the singular movements of continual rotation discovered by Mr. Faraday, with the action of magnets upon one another may be explained, by supposing that the latter are formed by an assemblage of electric currents disposed agreeably to a certain order which he was enabled to imitate, so as to obtain a real magnet, only by means of electricity.

Lastly, he has gone still farther, in shewing that an electric current possesses, like the compass needle, the property of assuming a constant direction by the action of the terrestrial globe. He has subjected this action of the globe, both upon the moveable current and upon the magnet, to that which an assemblage of electric currents would exercise when directed from east to west, towards the equator. Now every thing conspires to prove the correctness of this supposition. Davy has discovered by means of the piles, that all bodies which we call earthy, are metallic oxides; it is, then probable that below the oxidized crust of our globe, there are metals in a pure state, which are continually acted upon by the surrounding agents, such as water, and we have thus an active source of electric currents, on which the earth's rotation tends to impress a determined direction.

What an admirable connexion does the explanation of M. Ampere, which we have just presented, exhibit. It is the pile which teaches us that an electric current is under the influence of the earth; it is the pile which teaches us that all the substances of which the earth is composed, are metallic oxides; these two facts which at first view, have no other relation to each other, than that of arising from the same source, are found, by an ingenious theory, to have an intimate application to each other.

If we were to enumerate all the services which the pile has rendered to science, we should be obliged to surpass the bounds within which this article must necessarily be limited. We regret that we cannot enlarge upon the important labours of Mr. Becquerel, upon the recent researches of Mr. Savary relative to the very remarkable phenomena which he has discovered in the magnetism of steel by electric discharges, and that we cannot dwell upon other numerous experiments made by philosophers of various countries. The foregoing account is sufficient, we think, to shew what an inexhaustible mine of rich discoveries Volta has put into the hands of experimenters, in giving them the pile, and consequently, what legitimate claims he has upon their gratitude and their regrets.

It was our wish in terminating this article, to give some details relative to the life of Volta; but the journal from which we derived the article which has served as a text to the developments we have just given, gives us very little information on that subject.

We only observe that Volta was born at Como, in 1745, that in 1771 he was appointed professor of philosophy at Pavia, and that in that city, during twenty five years, he taught the true principles of electricity, and ornamented this science by his most valuable discoveries. In 1782 he made several journies in Europe with his illustrious colleague

Scarpa, and received from the Royal Society of London a gold medal for the discovery of his condenser. In 1801 he was at Paris, where he explained his pile; the Institute decreed to him a gold medal as a testimony of its admiration, and he was placed among the number of the eight foreign associates of that learned body. Advantageous offers were afterwards made to draw him to the great capitals, but he preferred his country to the brilliant prospects which were presented to him; he was no less, on this account, the European savant, so true it is, that true genius has no need of a large theatre, to be known and appreciated to its just extent.

Volta, aged and weary, retired to Como, where he continued to occupy himself with philosophy, and particularly with meteorology. A slow fever which had for a long time been weakening him, carried him off on the 5th of March last, at the age of eighty two years.

This is all we learn from the Italian journal relative to the life of this great philosopher of whom science is now deprived. We cannot help deploring on this occasion another loss which science sustained in the same year. By a sad coincidence, the same month, and even the same day which terminated the life of Volta, were the month and the day which witnessed the death of Laplace. A singular concurrence between two of the greatest geniuses of the age, so different otherwise, in the paths which they followed in the pursuit of science! If one by his inventive genius, has opened a new career to the sagacity of the human mind, the other, by a force of conception which raised him to the most sublime generalizations, has traced a route which no person, perhaps, will attempt to follow. The theory of the world begun by Newton can expect no future Laplace; that of electricity which owes its great progress to Volta, has a right to ask a Laplace.—*A. D. L. R. Bib. Univ. Juillet*, 1827.

Art. X.—*Double Stars and the Order of the Starry Firmament.*

(Translated for this Journal by Prof. John Griscom.)

In the year 1824 the observatory of Dorpat in Livonia, was furnished with the grand achromatic Telescope of Fraunhofer, the most remarkable instrument of the kind ever constructed. Four observatories, completely furnished with Instruments, have been founded in Russia within the last twenty years.

F. G. W. Struve, Director of the observatory at Dorpat, an able and excellent astronomer, has turned to an important account, the superiority of this new Instrument, in a more extended and accurate examination of double stars than has been effected by any preceding astronomer. The following are extracts from an analysis of his report on this subject by A. Gautier.

The new measures executed in England and at Dorpat, already surpass in precision those of the great astronomer to whom we owe the discovery of Uranus, on account of the perfection of micrometers. But the achromatic telescopes, hitherto employed have been greatly inferior, in their optical powers, to the reflecting telescopes of Herschell. A telescope, therefore which would bear a comparison with them, in those relations, and which had a decided superiority in its micrometrical apparatus, was very fit for obtaining interesting confirmation and giving greater extension to preceding discoveries. That which appears to me the most important (says Prof. Struve) was to undertake with the telescope of Fraunhofer, a review of all the stars of a certain brightness, in that portion of the sky, visible to me, in order to ascertain which among them is double. I entertained the hope of obtaining more positive knowledge on the manner of distinguishing stars physically and optically double, in order to be able to deduce some general views of the manner in which these stars are distributed over the celestial vault.

It is only under the equator that the whole sky can be perceived, by the earth's rotation, while at each pole, but one half is visible. In the latitude of Dorpat 121½° of the sky can be seen, viz. from the pole to 31½° south of the equator. But the southern stars rise too little above the horizon, to be successfully examined even by the most powerful instruments, for at those small altitudes the inferior strata of the atmosphere, produce a trembling in the image. I resolved in consequence to extend my review only to 105° from the pole, or 15° south of the equator. In this space the lowest stars were still 16½° above the horizon at their meridian passage. I divided this interval into twelve zones, according to the distances from the celestial poles and made my examination by zones. All the stars extending to those of the eighth magnitude and even the most brilliant of the ninth, which could be detected by the finder of the instruments, were brought successively into the field of view, in order to examine which among them were double. As soon as a star was discovered to be double, its position was determined by reading the index of the two circles of the instrument, as well as by the clock adjusted to sidereal-time; and a short description of the star according to its class and magnitude was inscribed in the register. When the power of two hundred and fourteen times, commonly employed, induced a suspicion that a star was double, by exhibiting it of an elongated form, a higher power extending if necessary to six hundred was substituted in order to decide the case.

The number of stars thus passed in review may be estimated at one hundred and twenty thousand. I then included in a catalogue the stars thus found to be double, comprehending those already known. This catalogue includes three thousand and sixty three double stars of the first four classes, of which three hundred and forty are found in the catalogues of Herschell, and four hundred and forty in my catalogue of double stars known in 1820. The following table shows the increase of our knowledge relative to the double stars of these four classes, and of each of them in particular.

Number of double Stars.	1st to 4th class.	1st class.	2d class.	3d class.	4th class.
In the new catalogue,	3,063	987	675	659	736
In the catalogue of Herschell,	340	76	76	82	106
In the catalogue of 1820,	441	96	112	111	122

The number of double stars is therefore nine times greater in this than in Herschell's catalogue, and those of the first class thirteen times greater.

I have constructed a chart of the double stars now known, situated in the northern hemisphere and to the fifth degree south of the equator, which will be published as an addition to the catalogue, and by which an estimate may be formed of the distribution of double stars over the celestial vault. This chart will show that double stars are to be found in every region of the heavens; but that their number, is less, in general in those where there are the fewest stars; and accordingly in the Great Bear, in a part of the Dragon, and in the Hounds, constellations most distant from the milky way, there is the smaller proportion of them.

From this region, the number of double stars increases as we approach the Galaxy, that is to say as the number of stars increase. There are however in the milky way, regions that are not more rich in double stars than the Great Bear, such as Cepheus, and Cassiopœ, and still farther south the region about the constellation Pegasus, and the anterior part of Andromeda. The richest regions are in Lyra, the north of the milky way, the Goose, the Fox and the Arrow. In Perseus also and to the north of the milky way, there is a great accumulation of double stars, while the Galaxy itself is not as well furnished as the Rams, the Triangle, the Fly, and a part of the Bull situated in the south. Finally, the constellation Orion, that region of the sky so surprisingly rich, on the south of the milky way contains a surprising number of double stars, while the parts of the milky way itself which follow it, such as the Unicorn, &c. are very barren of them. At a greater distance from the milky way on the north, in the Twins, and in the Lynx, and the Telescope, generally poor in brilliant stars, we find as many double stars as in those parts of the milky way south of these regions.

Since, of one hundred and twenty thousand stars that have been examined, more than three thousand have been ascertained to be double, it may be stated that the latter are about one to forty; but this ratio changes with the splendor of the stars. Flamstead determined more than a century ago, in the portion of the sky that we have reviewed, the place of two thousand three hundred and seventy-four stars; which are mostly of the first to the sixth magnitude. All these were examined by Herschell who found one hundred and sixty-seven, of the first four classes, double, and to them sixty-three have been since added. Thus of two thousand three hundred and seventy-four, as far as the sixth magnitude, there are two hundred and thirty double, viz. one to eleven.

The great catalogue of Piazza contains five thousand seven hundred and sixty-two stars. Deducting those of Flamstead, there remain three thousand three hundred and eighty eight, mostly smaller, among which one hundred and thirty four are double, which is one to twenty-five. As to the stars which are much smaller, whose position has more recently been determined, the proportion is about one to forty-two.

A reason for such a diversity in the ratios, cannot be given on the hypothesis of stars optically double. This diversity therefore furnishes a new proof of our preceding assertion; and we may explain the reason of the small stars appearing more rarely double, from the difficulty of seeing, at an immense distance the satellite star, often much more faint than the primary.

It is remarkable that among the double stars, newly discovered, there are several whose proper motion is already known. I will here mention only the brilliant star γ of the Whale, composed of a star of the third magnitude and one of the seventh; No. 42 in Berenice's Hair, composed of two stars of the sixth magnitude, remarkably near each other; and γ of the Crown, which, on account of the great proximity of the principal star of the fourth magnitude to its companion of the seventh, is one of the most difficult to observe. Our catalogue presents a considerable number of double stars of this description, a part of which had probably escaped former observers by the difficulty of distinguishing them. η of Hercules, and γ of the Crown may be considered, in this respect, as real touch stones of the perfection of telescopes, and they may serve to compare the power of these instruments, with that of the great telescope of Fraunhofer. I have examined with this instrument, the double stars of Herschell, a portion of which, such as ζ of Hercules, and δ of the Swan had become single according to his own observations, and another portion were no longer double according to later observers, because the power of their telescopes was less. I have discovered that they were double and have even proved the circular motion of the companions of the two stars above named, thus disproving the conjecture that the companion of one of them had disappeared. The star τ of the Serpent, is the only one seen to be double by Sir W. Herschell, which the instrument of Fraunhofer shows to be single. The low altitude of the star may have diminished the power of our instrument. I propose to observe it frequently; for the moment will surely arrive in which the companion will remove from the star whose brilliancy obscures it. The extraordinary force of our instrument accounts also for our seeing many stars triple, which were before only regarded as double. Thus Sir W. Herschell saw the star No. 7 of Taurus, as a double star of the fourth class, and all subsequent observers have so regarded it, the primary being of the sixth and the companion of about the tenth magnitude. But our telescope has proved that the primary itself is a double star of the first class, composed of two single stars of the seventh magnitude. Also according to Herschell as well as the observations previously made at Dorpat, and those of Messrs. Herschell, the son, and South, the star ψ of Cassiopœ was regarded as double. But our Fraunhofer has shown that the primary is composed of two very proximate stars of the ninth magnitude. All astronomers provided with good instruments have observed a trapezium of four stars, of various brightness, in the midst of the nebulæ of Orion. The two Herschells, and Schröter in particular, have examined this curious object. Our instrument however shows a fifth star, remarked by no preceding observer. Mr. Herschell has since observed it with his twenty feet reflector.

Our Sun is decidedly a single fixed star. If it formed a double star with some other, the latter must from its proximity, be distinguished from all others by its magnitude, much beyond that of Sirius itself, and its change of position in the heavens would characterize it still more clearly. Suppose for example, that the time of its revolution was equal to that of the companion of ρ Serpentarius, we should then observe in it a movement of more than seven degrees annually, and even if its revolution were a hundred times longer, its proper motion must be fifty times greater than that of 61 of the Swan, which is the most considerable hitherto observed.

Another question which arises from the consideration of this subject is, whether there does not exist between two stars of the first magnitude, some mutual relation, analogous to that of double stars, and which on account of their greater proximity to us, we do not at first discover. If we find any remarkable approach between stars of the first magnitude, such a relation would acquire some probability. Now there are in the northern hemisphere, three hundred and six stars of the first to the fourth magnitude, and three hundred and seventeen in the southern hemisphere, viz.

	1st	2d	3d	4th
Northern hemisphere,	9 stars,	26,	76,	195.
Southern do.	9,	26,	101,	181.

The smaller number of stars of the third magnitude, in the northern, being compensated by a greater number of the fourth. A calculation founded on those numbers, and compared with that which really exists, proves that there are not in the heavens, two stars of the first magnitude, sufficiently near each other to render it probable that their distance ought to be considered as fortuitous. In return the magnitude which we find in the first, presents us with examples of remarkable proximity. Who is not acquainted with the three brilliant stars of the second magnitude, in the belt of Orion, the two exterior of which are distant from the middle one, the one, only twenty-six, and the other eighteen minutes? Calculation proves that there are one thousand four hundred to one against the probability that this nearness is accidental. The constellation of the southern cross is still more remarkable. We there find, within the space of fifteen degrees square, (which does not comprehend the two thousand seven hundredth part of the celestial vault,) one star of the first magnitude, two of the second, one of the third, and one of the fourth; and the doctrine of probabilities shows twenty thousand to one against an accidental combination of this nature. We have good reason therefore to presume that these stars are dependent one upon another.

These conjectures are confirmed when we examine the stars to the sixth and seventh magnitudes, relative to their distribution in the celestial vault. According to a calculation of probabilities, founded on the number of these stars which are found in the catalogue of Harding, the case in which two among them should be distant from thirty-two seconds to a minute, ought not to exist more than once and a half, while we are in fact acquainted with fifteen examples. There ought not to be more than six or seven couples from the first to the seventh magnitude, in which the two stars forming the couple, should be distant from one to two minutes, and there are fifteen already known. If we wish to calculate on greater distances for stars of the sixth magnitude, we shall find that there ought not to be more than seven or eight couples distant from two to five minutes, while in fact there are eighteen. From five to ten minutes, probabilities give us twenty-seven or twenty-eight couple, and we are acquainted with thirty-six. We find more than calculation would grant, even at ten or fifteen minutes, namely twenty-five instead of twenty-two. We may then regard with great probability a considerable number of pairs of stars from the first to the sixth magnitude, in which the two stars are distant from each other from one to fifteen minutes, as belonging to a system of stars, stars really double, visible to the naked eye; and which are consequently, the more brilliant, and the nearest to us. Such as e. g. Nos. 16 and 17 and the two ν in the Dragon, Nos. 4 and 5 in the Lyre, the two α of the Balance, ζ of the Great Bear, and the well known star d'alcor, &c. We find a remarkable confirmation of this opinion in the circumstance already observed by Bessel that some of these pairs have a common and peculiar movement; such for example, are No. 36 of the Serpent and 30 of the Scorpion, and the two stars above mentioned in the tail of the Great Bear. It is also well worthy of remark that it frequently happens that sometimes one of the stars of these couples, sometimes, both are themselves double in the strictest acceptation of the word.

We meet also much more frequently three stars so near each other as to render it probable that they were not distributed at random. Among the one thousand three hundred and eighty-six stars of the first to the fifth magnitude which are in the charts of Harding, the cases in which there would be three within a circle of one degree in diameter are only one fourth of a time, that is, not at all, while it does in reality occur seven times, or twenty-five times oftener than if the distribution were fortuitous. Agreeably to these statements, we may therefore hazard the conjecture that the stars situated like the three δ in the Bull, the three ψ in the Water Bearer are stars physically triple which may be recognized by the naked eye.

Our review has afforded the means of discovering many nebulæ before unknown.

[The scientific world will doubtless review with interest and gratitude the remarkable performance, the general results of which are given in the preceding report. Every one may appreciate the toil which the execution of this task, in a climate so rigorous as that of Livonia, must have cost its indefatigable author; and must cherish the desire that Mr. Struve may continue for a long time to pursue his important researches with the fine instrument which he employs with so much advantage.]—*A. Gautier, Bib. Univ. Oct.* 1827.

Art. XI.—*Account of the Tracks of Foot-Marks of Animals found impressed in Sandstone in the Quarry of Corncockle Muir, Dumfries-shire;* by the* Rev. Henry Duncan, D.D. Minister at Ruthwell. Communicated by the Author.

The sandstone quarry of Corncockle Muir is situated between the rivers Annan and the Kinnel, about a mile and a half above their confluence, and not quite three miles from Lochmaben. It is near the top of a low round-backed hill, which stretches about half a mile in a westerly direction, almost in the line of the rivers.

The sandstone of which the quarry is composed is like most other sandstone in the county, of a reddish brown color, and is believed to be what is called in Britain the new red sandstone. Its texture is friable, and its strata of very unequal thickness. It lies in the direction of the greater part of the sandstone of the district, which is from west north-west to east south-east, with its dip southerly, inclining at an angle of 38.°

The remarkable phenomenon I am about to describe, as existing in this quarry, is that of numerous impressions, frequently distinct and well-defined, of the foot-prints of quadrupeds, which have been found by the workmen on the surface of certain strata, when the superincumbent layers have been removed in the process of quarrying. This fact, so extraordinary, and I believe *unique*, has not hitherto been noticed in any scientific work, though it is fifteen or sixteen years since the discovery was first made. It is not easy to convey an accurate idea of the nature of these impressions in words; but out of a considerable variety which have been observed, differing in magnitude from the size of a hare's paw to that of the hoof of a pony, I shall give some account of one remarkable track impressed on a slab, formerly in the possession of Mr. Carruthers of Dormont, (who procured it from the quarry some years ago,) and now forming part of the wall of a summer-house in the garden belonging to the manse of Ruthwell. On this slab, which is five feet two

* The Editor has been indebted to Dr. Duncan for this abridgement of his very interesting and valuable paper, which was read at the Royal Society of Edinburgh on the eighth of January last, and which will appear in vol. xi. part i. of their Transactions, now in the press.

inches in length, there are twenty-four impressions, which make twelve of the right feet, and as many of the left, being of course six repetitions of the mark of each foot. The marks of the fore feet are a little more than two inches in diameter, both from claw to heel and across, and those made by the hind feet are of much the same size, but somewhat differently shaped. The appearance of five claws is discernible in each fore paw, the three in front being particularly distinct. The three front claws of the hind paws may also be plainly traced, and are placed nearer to each other than those of the fore feet. There has obviously been no division in the sole of the foot, as is the case in the canine and feline species; but a gentle concavity of surface may be observed, especially in the fore paws, occasioned partly perhaps by the act of sinking in the wet sand. The depth of the strongest impressions is about half an inch; and it is observable that the fore feet have made somewhat deeper marks than those behind,—a fact which may either indicate a considerable length in the animal's neck, or the more than ordinary weight of its head and shoulders; for, had it not been for one or other of these circumstances, the chief pressure would have been thrown on its hinder paws, as is the case in some other specimens, because the surface up which it was moving, was of considerable steepness. The distance from the claw of the hind foot, to the heel of nearest impression of the fore foot on the same side, varies from an inch to an inch and a half. This, however, merely marks the position of the two feet when the hinder one was brought forward in moving; and if we would ascertain the animal's step—or rather the distance between the hind and fore paw, when the former was thrown back and the latter advanced—we must measure from the hind foot forward, to the second impression of the fore foot on the same side. Now, this gives a distance of between thirteen and fourteen inches, which is considerably more, however, than would have been the case if the animal had not been moving. If we compare this with the distance between the line of the right and left feet (which is, as to the fore-paws, nearly $6\frac{1}{2}$ inches, and as to the hind paws something more than $7\frac{1}{2}$ inches,) we shall see that an extraordinary thickness of the animal's body, in proportion to its length, is clearly indicated.

This description may be considered as applying, in its general features, to a considerable number of the impressions—I mean those of animals in the act of ascending. Not many tracks, however, have been found, of which the prints are so well defined, and several of them belong evidently to animals of different species. I am myself acquainted with five or six varieties which are clearly distinguishable—the largest of them indicating a quadruped of such considerable magnitude, that the distance between the impression of the hind foot and that of the corresponding fore foot, is more, if I am not greatly mistaken, than a yard and a half.

But there is another class of impressions which must be referred to the tracks of animals in the act of decending the steep face of the stratum. These are not less numerous than the other, but, for an obvious reason, they are not so easily recognized to be the prints of feet. The steep face of the stratum has caused the animals to slide in their descent, so that in most instances nothing is observable but the rut made by the heels of their fore paws, and sometimes also a slight mark of their hind paws, which must have rested lightly on the surface, while the animals were sliding their fore paws alternately downward, and sinking them in the sand to secure their footing.

Of both of those kinds of impressions, traces may at this moment be observed in the uncovered strata of the quarry, though there are none of a very striking character which have not been removed. The best specimins I have seen are in the summer-house at Ruthwell.

With regard to the species of animals whose tracks have been so wonderfully preserved, I am happy that as to three of them I can give the conjectures of a much more competent judge than myself, one of the first geologists of the age, Professor Buckland, with whom I have been in correspondence, having favored me with his opinion on the subject. That eminent individual, supposing the sandstone to have been deposited at an era when according to the received opinion, no animals existed on our earth of a higher order than reptiles, was induced to look to our present crocodiles or tortoises as the species most nearly resembling those of whose footsteps I sent him casts; and on making experiments with some live tortoises which he has in his possession, he has come to the conclusion, that to animals of this species the tracts belong. With regard to the sliding impressions in particular, he says that he fully adopts my theory of their origin, his tortoises, in going down a declivity over wet sand, having made " almost exactly the same impressions."

There are some curious facts connected with this phenomenon which have not yet been mentioned, and which the limits I must prescribe to myself will not allow me to do more than enumerate:—

1*st*, In most instances the counter impressions are distinctly marked in relief on the under surface of the layer covering the foot prints, these projections corresponding to the cavities below as exactly as a cast to its mould.

2*d*, The impressions never occur but on what the workmen call a clay face, by which is meant a stratum, the outer coat of which has a slight admixture of clay, rendering it harder than the rest of the rock, accompanied sometimes with a thin layer of soft clay in the seam between the under and upper stratum.

3*d*, All the tracks are constantly in a direction either up or down, sometimes inclining a very little either to the right or left, but never running across the slope in any great degree.

4*th*, In most of the impressions there are marks of the matter being displaced by the foot-marks, and wherever such an appearance occurs, the matter is found to have been carried directly downwards, with reference to the present inclination of the quarry.

These two last circumstances, as well as that of the sliding tracks, prove that the strata must have been very much inclined, while in a soft state, and while in the act of forming though this is contrary to the received opinion as to the formation of sandstone.

5*th*, The sand must have possessed very considerable tenacity, and have even been sometimes skinned over with a stiff coat, for in one of the specimens preserved at Ruthwell, the claws of the animal had evidently broken through the outer coat at every step, and in two others, where the hind paws have rested on the matter just displaced by the fore paws, their pressure, instead of obliterating the appearance of superadded matter, has merely caused an indentation of the part rested on.

6*th*, There are continuous strata of sandstone resting on those in which the impressions are found, for the distance of not less than a quarter of a mile, all of which must have been deposited subsequently to the period in which the tracks were left on the surface of the sand.

7th, As far down as the quarry has yet been worked, which is not less than forty-five feet perpendicularly from the top of the rock, similar impressions have been found, and these equally distinct and well defined with such as are nearer the surface.

8th, The impressions are not confined to a single stratum, but have been found on many successive strata. Since the foot-marks were first discovered, about forty yards of sandstone have been removed in a direction perpendicular to the line of strata, and throughout the whole of that extent, impressions have, at frequently recurring intervals, been uncovered, particularly in one part of the quarry, and still continue to be uncovered.

Hence it must be inferred that the process, whatever it may have been, by which the impressions were buried in the sand, that of drifting by storms for instance, has not been occasioned by any sudden or isolated convulsion of nature but has been carried on through many successive years or rather ages. Nor has it been the result of tides on the shore of the sea, which can scarcely be supposed to have flowed to the height of between forty and fifty feet; and even if they had done so, would certainly have swept away or filled up any impressions which animals might have made at low water, by moving over the surface of the sands they were depositing.

In the midst of so much difficulty, it is not easy to form even a plausible conjecture as to the manner in which the sand composing the rock was originally accumulated. It might, however, be perhaps worth while to inquire whether or not this successive accumulation could be the effect of the drifting occasioned by violent winds from the south-west. Supposing a sand-hill to be thus formed, a period of rainy weather following the stormy season would soften and diffuse the particles of clay, which may easily be believed to have mingled with the sand-drift, and would not only prevent the sand from being again moved by the wind, but would form it into a substance of some tenacity, resembling mortar, well fitted for preserving any impression which it might receive. If, during or immediately after the rainy season, animals were to traverse a hill thus formed, their tracks would be either altogether obliterated, or partially filled up, of which latter state many traces are to be found in the quarry; but when the surface had begun to dry, the foot-marks impressed on it would remain a considerable time quite distinct and well defined. Now, supposing the stormy monsoon again to commence, the neighbouring sands, which had not yet been fixed by any mixture of clay, and which happened, from their situation, to be easily dried by a few days of favorable weather, would be suddenly drifted on the hill in question, forming a layer which may easily have covered over the half-indurated surface, without being incorporated with it, and without in any way injuring the form of the footsteps imprinted on it. Let the monsoon be now supposed to continue during the whole course of a dry summer: Fresh layers of sand would be drifted, pure at first, but mingled again towards the close of the season with the clayey dust swept from an arid soil, which mixture would form the materials of what the quarry-men know in its present state by the name of a *clay-face*, and would once more, when subjected to the operation of the returning period of rain, both fix the sand, and prepare it for the reception of permanent impressions of the tracks of wandering animals. Thus from year to year the same round would be continued, and the same appearances would take place, till, after the revolution of many ages, what was originally sand would be converted, by a common process of nature, into sandstone and being exposed, in common with the rest of our globe, to those mighty but mysterious convulsions of which there are every where such incontrovertible proofs, would at last, by the submersion of the universal deluge, be buried under its present covering of soil.—*Dr. Brewster's Jour. for April*, 1828.

The following jeu d'esprit from Newton's Journal for April 1828, may amuse our readers, without invalidating the very interesting discovery to which it alludes.—*Ed. of this Journal.*

Fossil Remains.—It will be remembered that the Rev. Mr. Buckland distinguished himself a few years ago, by discovering a cave at Kirkdale, which he proved to be the dining room of antediluvian hyenas, that had in this retreat feasted upon elephants and water-rats, and left nothing but the teeth of these tit-bits, just as records of their good living, and bones of contention for future naturalists and cosmogonists. The same ingenious gentleman has lately had the good fortune to find a piece of red sand stone, bearing on it the traces of an antediluvian tortoise's foot steps. The whole geological world has been in raptures at this discovery; and in order to make sure of the fact, that the steps traced in the stone were the steps of a tortoise, a meeting of the Society was held, and some soft chalk was prepared, on which a modern tortoise might make his mark, and thus authenticate as it were, the signature of his ancestor. Every thing being ready for the demonstration, and the interest of the scientific company wound up to the highest pitch, the tortoise was placed on the chalk, and, first of all, he flatly refused to stir a step. The members, upon this very properly waxed impatient, got in a rage, and began kicking and banging him about, and maledicting him in an extremely moving manner. They had much better, however, have refrained from these stimulants, for when the tortoise was at last prevailed on to walk, he insisted on walking as straight as an arrow; whereas the antediluvian tortoise's march was as crooked as a ram's horn. The Society were aghast at the discrepancy. Various arguments however, were used to console them. It was suggested, that the tortoise might have forgotten the true manner of walking while confined in the ark; and that owing to this circumstance, the proper step might have been lost by its descendants. Or it might be, that chastened by the deluge, his slow race had returned to the path of rectitude, which they had, in the universal degeneracy, wilfully deserted for devious ways. Or, perhaps they had one way of walking on red sand stone, and another on soft chalk: one manner in private, and another before scientific beholders.*

ART. XII.—*Observations concerning Fossil Organic Remains; by* J. E. DOORNIK, M. D. &c. Communicated for this Journal, by the author, in French MS. and translated by Charles U. Shepard.

Remarks upon M. Cuvier's method of explaining the importance of organic remains in geology.†

THE study of fossil remains is, without doubt, one of the

* The learned Society here alluded to, will we are persuaded excuse the harmless raillery of our anonymous correspondent. Subjects that have formed the pursuit of a Cuvier and a Buckland, can never be of themselves ridiculous, it is only when they fall into the hands of dilletanti philosophers, that they can be stigmatized as puerile.

† G. Cuvier, sur les ossemens fossiles, &c. Paris, vol. 3. edit. 1825. 1. vol. p. 29

principal branches of Geology: one of the best established means in the explanation of the most important phenomena connected with the natural history of our earth. It is, therefore of the utmost importance that we should be familiar with the whole series of organic remains, before we form our ideas upon the subject in its full extent, and before we allow ourselves to undertake an explanation of the apparent labyrinth.

Notwithstanding my conviction of the great utility of a thorough knowledge of organic remains, as connected with the genera and species to which they belong; the various localities where they are found, and the situations which they occupy in the different strata—belonging to epochs so remote: still, I cannot subscribe to the views of M. Cuvier, when he speaks of the high importance of organic remains.

"Why—do we not perceive, that to *fossil remains alone*, is due the origin of the theory of the earth; and, that without them, we should possibly have never dreamed, that there had been in the formation of the globe, *successive epochs*, and a *series of different operations?*"

This is, truly, a position which allows of infinitely more in its principles than could have been granted by any logical deduction. If it is solely *to fossil remains that the origin of the theory of the earth is due*, then every other consideration for such a theory is excluded. According to the position of M. Cuvier, there exists but one cause from which the theory of the earth has taken its origin; and that is, the study of *fossil bones.*

Such a position it seems to me proves too much, and therefore nothing, decidedly.

After having read and meditated much upon it, I take the liberty to ask M. Cuvier if the knowledge we possess concerning the various rock formations,—the manifest differences in their constituent parts; in the succession, alternation and regular recurrence of their strata; that relating also, to the obvious order which reigns in the superposition of rocks, and the striking instances of conformity, of indentity, of equivalence and parallelism in these superpositions,—proved by the researches of the most able geologists, and found true in countries the most remote from each other: I would ask, if such knowledge is not sufficient to afford some positive data in a theory of the earth—and whether we should not add to it whatever may be derived from the study of fossil remains, so that they may mutually assist each other, and become two inseparable sources from whence we may derive the materials of a theory of the earth?

According to the views of M. Cuvier, then, a theory of the earth should be the result of a knowledge, which is partial; whilst it ought to be on the contrary, the result of a knowledge which is general, and which embraces every thing belonging to the science of GEOLOGY. The discovery of fossil remains; the observation of differences among their genera and species; their diversified appearance when in different strata, and the epochs to which they may be supposed to belong,—are so many materials for framing a theory of the earth; but they are not the only materials: they merely cooperate with other branches of knowledge to form a complete system.

Therefore I maintain, *that the origin of the theory of the earth cannot be attributed, exclusively, to organic remains.*

The arguments which I have cited, prove, if I mistake not, that we, already, had collected many materials for the commencement of a theory of the earth, previous to any progress in the study of fossil remains, and their scientific classification, founded upon comparative anatomy; for which, we are indebted to M. Cuvier as the original author.

I take it for granted that M. Cuvier in advancing this position forgot for the moment, that he was accusing the great WERNER of not having given sufficient attention to the study of organic remains. Nevertheless, Werner had erected a geological system, which has rendered the name of this distinguished philosopher immortal, although according to the opinion of M. Cuvier, he did not sufficiently occupy himself with what he maintains to have been, and to be, the only foundation for a theory of the earth. Every one will maintain with me, I think, that Werner has laid the foundation of Geology. His labors have brought to light materials, which are, and must always remain of the highest value in the formation of a theory of the earth; although connected with a class of knowledge different from that, which is derived from the study of organic remains.

Finally, let us suppose for a moment, that we were ignorant of all that is at present known concerning organic remains; and that our geological knowledge was limited to what we know of those formations called primitive, transition, secondary and tertiary, gathered from their conformation, structure, position, and mutual relations—information purely geological; that our knowledge was confined to what has been observed concerning the summits of mountains; their planes and bases; concerning lakes and valleys; and to the removal of immense masses of rock, to great distances; is it probable that there could be a philosopher found, who would maintain that this amount of knowledge does not, or could not contribute to furnish the materials for a theory of the earth? I cannot believe it, or ever persuade myself that M. Cuvier seriously meant to maintain such a proposition. His vast erudition in every thing which relates to physical science, forbids my believing it; and I choose to think that the passages which have been cited are, so to speak, slips of the lively pen, of this justly celebrated author.

A little farther on we read, "It is only by analogy that we have extended to primitive formations the conclusion, which organic remains furnish, *directly* for the secondary formations; and if there had only existed formations without fossil remains, *no one could have maintained that these formations had not been simultaneous.*"

Here I must commence with the same remark that I have just made upon the first position, which is, that M. Cuvier, assumes infinitely more than sound logic will sustain him in doing. I allude more particularly to the latter part of the above quotation, where he says "and if there had only existed formations without fossil remains, &c."

Truly, when this point shall be yielded to M. Cuvier, geology will lose very much of its dignity; for the science must then acknowledge that it owes every thing to our knowledge of organic remains. But how shall we make a position of this sort agree with what we know concerning the constituent parts of rocks of different composition—information derived entirely from chemical analysis? How shall we then dispose of our discoveries relating to the different structure of formations, which are so geologically distinct, that they have based upon this circumstance the characters for distinguishing the formations?—Is not all we know concerning succession in the primitive formations, directly the result of observations purely geological? Are we not able to distinguish successive formations in strata, which do not belong to the primitive? Should we confound the formation of chalk with that of the *calcaire grossier*, if deprived of the aid of their imbedded fossils, when there exists the formation of plastic clay, of *molasse* and conglomerates of various kinds, intermediate between these strata? In every formation, from the lowest to that which is uppermost, we perceive a repetition of rocks and strata, whose chemical composition is similar; that is, siliceous, argillaceous or calcareous. But the difference in structure is most obvious. The lower formations are crystallized and firm; whilst the upper are earthy and loose. The intermediate formations differ from these, as well as from each other, in a manner no less remarkable. A striking character of the transition formation, and which separates it from the primitive and secondary (more properly "tertiary") is seen in the alternation of a series of rocks, in which there is a regular recurrence of similar beds, rendering perfectly obvious, likewise, the limits of this extensive class of rocks. Another characteristic of the same formation exists in the three great formations which hold nearly the same rank in different parts of the globe; They are, 1st, talcose granular limestone, graywacke with anthracite and mica slate; 2dly, syenite and porphyry with crystals of hornblende, and occasionally quartz; 3dly, clay-slate, graywacke and black limestone.

The mica slate with anthracite and clay slate serves as the connecting points of the transition with the primitive; whilst on the other hand, the fine grained graywackes and porphyries, abounding in the crystals of quartz cause it to approximate to the secondary.

The different ages of these formations are likewise indicated by their position. For example, the porphyries of Guanaxuato repose upon a bituminous clay-slate, those of Hungary upon a transition mica slate, whilst those of the Andes, of Quito are situated upon primitive rocks; large masses of graywacke are to be seen in the oldest slate rocks of the transition class; whilst extensive beds of graywacke are met with, whose origin is more recent. In fine the transition class of rocks is distinguishable both by structure and age from the primitive,—the limits of the latter are in general simple; while those of the former are more complex.

When we observe the highly uniform and decidedly crystalline structure in the primitive rocks; when we view this character much less distinctly in the transition; still less in the secondary; and not at all in the tertiary; is it probable that a geologist could be found, who would maintain that they were, nevertheless, all formed at the same epoch?

It is well known, that over an extent of some thousand square leagues, (in Thuringia and all the northern part of Germany,) nine of the upper formations, viz. the transition limestone, the graywacke, the red sandstone, the zechstein with bituminous shale, the muriatiferous gypsum, the oolitic limestone, the gypsum in clay, the muschelkalk, the white sandstone, and the quadersandstein, have been distinguished from each other without the aid of zoological characters.*

M. Cuvier in his theory of the earth after having done justice to the high reputation of Werner observes, that neither M. Werner or M. de Saussure—the geological historian of the Alps, *have described the species of the organic remains in each of the strata, with that accuracy which has now become necessary, since the number of animals already known is so great.*

It is true Werner was not so well versed in comparative anatomy as M. Cuvier, who in this branch surpasses all his predecessors, and probably his contemporaries also; yet I will venture to say to M. Cuvier, that it appears to me he is not acquainted with the merits of Werner in contributing to the promotion of the natural history of organic remains. Far from confining himself to the mere science of mineralogy, in forming his theory of the earth, Werner from the first occupied himself with the study of the different relations of all the classes of organic remains. A genius like his must naturally have perceived that a complete knowledge of these relations was absolutely necessary to a geologist, and accordingly, with such a conviction, he informed himself of all that was known of petrifactions. During his lectures, he often called the attention of his auditors to the importance of forming collections, which besides a complete series of rocks and minerals, to illustrate the formation of our globe, he insisted, ought also to embrace an extensive collection of organic remains, both of vegetables and animals. Neither did he neglect, at the same time, to make mention of the numerous researches and discoveries, relating to those caverns which contained large quantities of animal remains.

Werner also insisted much upon the observation, made, if I mistake not, by M. Lister, more than one hundred and fifty years ago, that the different formations were capable of being distinguished by means of the fossil remains they con-

* See Humboldt on the superposition of rocks.

tained; and also, that these relics were first apparent in the transition class, though in a very small proportion; and belonged only to the class of zoophites and testaceous animals. Thus he explained, most decidedly, the antiquity of the marine and terrestrial animals; maintaining that the first possessed the most ancient origin.

It was, when pursuing these investigations, and engaged in the study of the genera and species of organic remains, that, with his customary sagacity, he remarked, how widely those species differ which are the products of more ancient rocks, from such as exist at the present day; and on the contrary, how closely those species which occur in the most recent formations, approach to existing animals.

To conclude, here is another observation of Werner, by which it is proved, beyond a doubt, that he attached a high importance to these studies. He insisted upon the observation that many fossil species are limited to particular rocks, while others, on the contrary, possess a wider distribution; these last appearing to have enjoyed an organization which enabled them to live during a variety of changes, which exterminated those found only in particular rocks.*

My profound veneration for the high merits of Werner has occasioned the foregoing remarks, and which, I trust, have been made with propriety.

Geological question proposed by M. Brongniart.

(Descrip. geolog. des environs de Paris, p. 92.)

"When we have in two formations remote from each other, a difference of structure, but the same organic remains; ought we to refer them to different series, or in consequence of the general and easily ascertained resemblance of the imbedded fossil remains, to consider them as belonging to the same formation, when not opposed to any fact connected with the superposition of rocks elsewhere?"

Reply of M. Brongniart.

"We should not forget that one of the principal objects of geology is to determine the different epochs which have succeeded each other in the formation of the globe, and to ascertain the particular strata which were formed at these epochs.

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* See Prof. Jameson's notes to Cuvier.

" But we will admit that strata widely differing from each other may be formed at the same moment, not only in different parts of the globe, but even in the same place.

" We cannot deny a conclusion drawn from facts immediately under our eyes; for whatever takes place upon the surface of the globe, belongs to the same geological epoch, and which commenced at the moment when our continents took their actual form: and although this epoch may have a character of stability or repose, in the geological phenomena it presents, which does not permit, except in a few cases, the formation of new rocks; nevertheless, it produces still a few of these for our observation; for example, the lavas of Vesuvius and other volcanos, the calcareous tufas formed in many of our streams, and the siliceous sinters in those of Iceland; all of which, are, mineralogically, quite distinct from each other; but the organic remains they enclose have all the common character of belonging to a creation formed since the commencement of this epoch. To desire a greater number of examples, and of course, proofs of a similar truth, would prolong, unnecessarily, an argument already somewhat extended.

" It is not the same with generations of organized beings; they can be, it is true, destroyed in an instant; but a long time is requisite to create them anew, in order that they may present the number and the varieties of development which they now exhibit. This development requires a long series of ages; or at least of years, which establishes a true geological epoch; during which, all organized beings which inhabit, either the whole surface of the globe, or at least a very large part of it, have assumed a peculiar character of family or of epoch, which, though it cannot be defined, cannot be mistaken.

" I consider then, those characters relating to the epochs of formations, which are taken from organic remains, as of the first value in geology, and as superior to all others, however valuable they may appear: thus, even when characters drawn from the nature of the rocks, (and these are very weak,) such as the height of the strata, the hollowing out of vallies, likewise the inclination and contrasted stratification of beds,—are found in opposition with such as are furnished us by organic remains, I shall allow to the latter the preponderance: for all these effects may be the result of a revolution, or of a sudden formation, which does not form in geology a special epoch. Without delaying to prove this principle by farther arguments, it shall suffice me to cite a single fact. The strata at Calabria have been these thirty-eight years, the scene of the most frightful disorder; horizontal beds have become vertical; entire strata have been transported to a distance and deposited upon those which are different; yet no geologist has proposed to regard these facts as proofs of a different geological epoch. For a change in organized species, circumstances of a very different nature, and catastrophes much more general and of a longer duration would be requisite: in a few days the strata of Calabria have shown us derangements similar to those we witness among the Alps; whilst, five or six thousand years have not given rise to any appreciable difference in the forms, and other characters of organized species.

"I do not however mean to assert that characters taken from the relative situation of strata, (but not from their *evident superposition*,) from their very nature, ought not to be employed with confidence by the geologist in the determination of the different epochs of formations. Alone, or united to those we draw from the nature of fossil remains, they are of the highest value; but I merely contend, and I think I have given reasons sufficiently weighty for my belief, that when these characters are in opposition to those we obtain from the presence of organic remains, the last ought to have the precedence.

"Nor do I conceal that it is necessary to bring the greatest circumspection to the use of these characters; I am aware that it is necessary to know how to distinguish and calculate the influence of distance and of climate upon the different species; that it is necessary to be able to appreciate the apparent and sometimes real resemblances which occur in formations evidently quite distinct, and to recognize some species which have enjoyed the rare privilege of surviving the destruction of their contemporaries, and of constantly remaining the same, amidst all those catastrophes which have taken place around them.

"I am not ignorant either that it is also necessary to know how to distinguish those individuals which have been detached from other strata, and brought by some cause or other into those which are more recent, and how to separate them from those which have lived in places, and at epochs, which the species to which they belong ought to characterize. I understand all these difficulties, and am upon the watch against such causes of deception, that introduce into geology those uncertainties which we find in all the sciences, and which require of the geologist, constant attention and labor, in order to select those species from which he ought to draw his characters, and to attach to them their due importance."

Remarks upon this reply.

Upon the reply of M. Brongniart to the question proposed by himself, I observe in general; and in the first place, that it appears to me he does not make a distinction between the words *period* and *epoch;* yet the difference between the ideas which these two words imply is too great to be confounded. *Epoch*, in my opinion, is distinguished from *period* under the relation of duration of a greater or less extent, and also that of consequences which flow from it. *Period* is a progressive succession for a given time, during which many acts succeed each other, or many developments take place at different times and remote from one another. In consequence of this distinction, we say that some facts though very different from each other, as regards their nature and their mode of existence, have taken place in the same *period;* but we could not say or maintain that these different facts took place at the same *time:* they have occurred progressively, at different *times*, though in the same *period;* or in other words, they have taken place at different *epochs* in the same *period.*

By neglecting this logical distinction, we make events contemporaneous, which have occurred at *epochs* quite distinct, and therefore introduce a degree of confusion into the science which is calculated to impair the accuracy of our observations.

We can say that various formations may have been formed in the same *period*, but we cannot say that these same formations were formed at the same *epoch:* such an error would undermine the foundations of the science as relates to the superposition of rocks; a subject which has been so elegantly elucidated by M. de Humboldt.

"But we will admit that strata widely differing from each other, may be formed at the same moment, not only in different parts of the globe, but even in the same place."

I frankly avow my dissent from M. Brongniart, in the opinion here expressed. I cannot imagine how different rocks can be formed at the same time and in the same place. Geology has made us acquainted with a series of formations of quite a different nature, and whose characters are sufficiently distinct to prove to us that they belong to epochs decidedly different.

The mica-slate, the alpine limestone, the sandstones with lignite are rocks whose nature is very different, and I cannot believe that any one would wish to defend the idea that these rocks could have been formed in the same moment and in the same place, whilst every thing announces to us, that they belong not only to *epochs* but to *periods* widely remote. Truly, by admitting such a doctrine, we run the hazard of confounding geological phenomena in such a manner, as, that finally we shall lose the path which alone can conduct us to the true knowledge of things.

M. Brongniart informs us, that whatever has taken place upon the surface of the earth, belongs to the same *epoch* or *period*. I cannot allow, it belongs to the same period with that in which the earth was, when it recovered itself after the last great catastrophe: a *period* continues, but this period is divisible into many *epochs* which are truly distinct from each other. It is true that the organic remains contained in the newer formations, possess all those characters which are common to the tribes now occupying the face of the earth; but it does not follow from thence, that since the organic remains possess a similar character, that different strata ought to be regarded as belonging to the same *epoch* of formation. I allow they may belong to the same *period*, but not to the same *epoch*. Many active volcanos, belong to the *period* in which we live, but not to the *epoch;* and that they do not, is obvious from their ejected matters. For it is ascertained that lavas of the same volcanos, differ at different *epochs;* and we can easily conceive that volcanic products, evolved during a period of thousands of years would differ from each other, and that they would evince by this difference, the distance of the epochs which separate them. The differences, then among volcanic products, are so many proofs that they were formed at different epochs. Organic remains may possess a common character, as well as rocks which are the result of different formations and epochs widely remote. Since the period, successive to the last great catastrophe, the earth has certainly undergone partial derangements, but which have not interfered with the existence of genera of plants and animals. Thus we find, although in formations of different epochs, organic remains, that bear the common character of the *period*. That which is true of the *period*, in which we exist, may not be true of the preceding periods; and totally different formations, belonging to periods widely separated, together with differences among fossil remains, which relate both to their genera and species, prove abundantly, that the opinion of M. Brongniart, is not correct. All that we can safely infer with regard to the past, is, that events have transpired as we observe them taking place now. That is to say, that species of animals have continued to exist, notwithstanding those great changes which the earth has undergone ; and that therefore, we find similar organic remains, in strata belonging to different formations, and to different epochs. But we shall continually fall into error, if we admit, from the similarity of these remains, that the rocks which contain them, are contemporaneous and belong to the same formation : such a consequence embraces much more than the ground of the similarity in fossil remains will justify.

I cannot therefore, with M. Brongniart consider those characters connected with the epochs of formations which are derived from the agreement of organic remains as of the first value in geology; and much less, that they ought to have the preference among all other characters how important soever they may be.

Well marked differences, both in different formations and in separate periods and epochs, are, and will continue to be of so high a value in geology that they can never give way to those derived from the similarity of organic remains without introducing perplexity into the science, and neglecting its true principles. But to pursue the remarks of M. Brongniart.

"Thus then" (he continues) "when the characters taken from the nature of the strata, &c. are found to be in opposition to those which we obtain from their imbedded remains, I shall still allow to these the preponderance." It is not at all necessary that the former characters should be in opposition to those derived from zoology : the formations may be of a different nature, and separated by different epochs whilst the organic remains may possess a similar character. The pachydermata, the palæotheria, the anoplotheria, &c. appear to have been destroyed at a period entirely distinct from that, in which our mammoths, rhinoceroses, hippopotamuses, &c. were entombed. The rocks which contain the first may belong to different formations as well as epochs, notwithstanding there exist a resemblance and similar characters among the pachydermata; but we can never deduce (according to the established principles of geology) from such an analogy in the organic remains of this period, that these formations are contemporaneous.

The instance of the confusion in the strata at Calabria mentioned by M. Brongniart, does not prove what this philosopher wishes to deduce from it. "Horizontal strata have become vertical,—entire masses of the formations have been transported and deposited in contrasted stratification, upon other strata." Very well! Let us suppose we had lost all historical trace of this disaster at Calabria, no geologist would regard these masses, as belonging to a distant geological epoch (or period.) In order to shun such an error he would compare the masses which had been displaced and the strata upon which they had been deposited, and from these observations he would be able to explain why they do not belong to a *period* geologically different, though happening at an *epoch* in the course of this *period*, and different from other *epochs* of the same *period.* But, besides, a fact of this kind, isolated, local and confined to so small a portion of the earth, could not compare with those great changes which have taken place at different periods and upon an infinitely larger scale.

To conclude these remarks I subjoin the following observation, concerning the conformity of position among rocks. "There may exist *an identity of structure*, (that is to say of mineralogical composition,) and a *diversity of organic remains*, or *diversity of composition* and *identity of organic remains.* The rocks β, and β, situated at remote horizontal distances, between two identical formations α and γ either belong to the same, or to parallel formations. In the first case, their composition is similar; but on account of their distances from each other and the effects of climate, the organic remains they contain may differ from each other. In the second case, the mineralogical composition is different, but the organic remains may be similar. We are to regard the words "*identical formations*," "*partial formations*," as indicative of conformity, or of non conformity of mineralogical composition: but they cannot enable us to decide *a priori* as to the identity of the fossils. It is sufficiently probable that the deposits β and β situated at great horizontal distances, from each other, placed between the same rocks α and γ are formed at the same *epoch*, because they contain the same organic remains, and possess the same composition; it is not on that account, equally probable that the epochs of their formation are very distant from each other, when the fossils are dissimilar. We conceive that in the same zone, in a country of small extent that the generations of animals have succeeded each other, and characterized as it were, by peculiar types the epochs of their formations; but beings of various forms at great horizontal distances, may have occupied at the same time, in different climates, the surface of the globe, or the basin of the sea. We may observe farther, that the position of β between α and γ proves that it is anterior to the formation γ and posterior to that of α; but there is nothing which, enables us to measure the interval of time which elapsed between the deposition of the strata; and the different isolated deposits of β may not be simultaneous."

I have taken my last remarks from the essay of the celebrated M. de Humboldt *upon the superposition of rocks*, because they appeared to me to be connected with those observations which I have taken the liberty to offer M. Brongniart, with that respectful consideration, which I entertain for the merits of so distinguished a philosopher.

Observations upon the situation in which Organic Remains are found.

Among the observations which have been made upon the position of organic remains, this certainly is a highly important one; that different strata belonging to distinct rock formations, or to the same formation, as is sometimes the case, are distinguishable by means of vegetable and animal remains, which appear to be peculiar to these strata, or at least, are but rarely noticed in others. Thus we find in the great coal formation, a large number of vegetable fossils peculiar to this formation, and very unlike existing plants. They are referable to the arundinaceæ, of which, some approach to the genera of the present day; but a greater number belong to an order quite peculiar, and distinguishable by the cortical part, which is covered entirely with regular impressions arising from the petioles of the leaves. This discription of plants is supposed to have an affinity to the order of palmaceæ, and to an anomolous division, constituting an intermediate order between the palms and the conifères. Among the vegetable fossils of this formation, we find the very curious *Phytolithus palmatus*, of SHEINHAUER, belonging to the *Lepidodendra.* To which succeed the *Syrengodendra*, and a plant, different from all the rest, described by M. STEINHAUER, the *Phytolithus transversus.* But among all these vegetable remains, which occur in the coal formation, there are none which present themselves in such abundance, as those which are allied to the *Conferve.* Another characteristic trait of this formation, in relation to the organic remains it contains, is, that we find in it, a small quantity of animal remains, belonging to the *Testaceous* tribe. We find in it, no remains of animals belonging to a higher order, but in ascending to the strata of bituminous slate, above the coal formation, we begin to meet with those of quadrupeds, and reptiles of the lizard family.

We find, also, nearly in the middle of the Derbyshire Coal formation, in the ninth stratum (counting in an ascending order,) a stratum of a ferriferous rock (iron-stone,) which is filled with different species of *mytile*, which is distinguished by the name of *bande à mouler.* The shells are univalves and bivalves.

The existence of such a stratum, with such organic remains, gives rise to the following question, which I think is is sufficiently important, to be introduced in this place. Do these testaceous remains, among which are *Ammonites*, *Orthoceræ*, and *Terabratulæ*, *Mytilus crassus*, and three species of *Unio*, belong to marine, or fluviatile shells?

Undoubtedly, the *Ammonites*, the *Orthoceræ*, and *Terabratulæ*, belong to the marine class; but we are accustomed to regard the *Unio* as fluviatile, and the *Mytilus crassus*, as fluviatile, also, and belonging to the genus *Anadonta.* Along with Conybeare and Phillips, I doubt myself, if we are not in an error upon this point. I am aware, that conchologists admit the genus *Unio*, as separating the fluviatile from the marine shells: but we ought not to neglect, at the same time, the circumstance that the form of the hinge—admitted as a distinctive character, is common to different species found in the fossil state, and in situations, which render it certain that they belong to the marine class: thus we find in many of the oolites, in the lias, shells, called in consequence of their hinge, *Unio*; occuring accompanied by others, which are indubitably marine; for the reason, that they exist in too great abundance, and too constantly in the same strata, to have been fluviatile, and accidentally introduced. Now some of these *Unios*, so called, which are also found in the oolite, and the lias, are also found in the coal formation; and as it is so probable that the shells of the oolite are marine, we have, I think, very slender grounds for calling those found in the coal formation, fluviatile.

The formation of chalk is characterized by the family of *Echinites.* The quantity of fossil remains of this family alone, is certainly equal to that of all the other species found in it. Thus also the *Ostrea deltoidea* is the most characteristic shell in the oolite formation; whilst in the red marl, we never find a single fossil remain, and, whilst the gypsum, *le gypse à ossemens*, in the vicinity of Paris, owes its name to the quantity of organic remains it contains. I might multiply examples, if I did not suppose, I had already cited a sufficient number. We will then turn our attention to another question which I deem of considerable importance. Is there any constant connexion between the antiquity of strata, and the similarity or dissimilarity of their contained fossils, compared with existing animals?

The more ancient are any strata, that is, the more ancient the formation with which they are connected, the greater will be the dissimilarity of the fossil remains they contain, to existing animals. This observation is generally true, as relates to vegetables, to zoophytes, to vertebrate and invertebrate animals, as well as to quadrupeds, both oviparous and viviparous. And on the contrary, the more recent is any formation, the greater is the resemblance of its contained fossils to living beings. Of this we may satisfy ourselves, by consulting the distribution of organic remains in the different rock formations, and the enumeration of fossil animals according to the epochs of their appearance upon the earth.

The primitive formation of the Granite; not yet alternating with gneiss; complete in its constituent parts; unstratified; abounding in quartz; fine grained; destitute of minerals which are foreign to its primitive composition; without subordinate beds of primitive limestone;—the primitive formations immediately succeeding the granite—gneiss, gneissoid granite, granite intermediary between gneiss and mica slate; mica slate, clay slate, &c. forming along with the primitive granite, the great frame-work of the earth at that period,—are destitute of every trace of fossil remains. This is the distinguishing trait of the rocks of this period, and widely separates them from those which succeed.

The period succeeding that of the primitive, less ancient, yet very remote, begins to present us with fossil remains; vegetables, zoophytes, molluscous and crustaceous animals —entirely different from the species we now see, though possessing some analogy to our genera.

If we advance in this enquiry concerning the traces of life, and compare for example, the vegetable remains of different strata—the *Arundinaceæ*, the *Filices*, &c. of the coal formation; the *Exogenites*, the *Endogenites*, the *Calmites*, the *Lycopodites*, the *Phyllites*, of the calcaire grossier, we shall perceive that they all belong to a former world.

Among the animals, the *Ichthiosauri*, the *Pleisiosauri*, the *Palaeotheria*, the *Anoplotheria*, of a more recent period, are so many incontestible proofs of this difference, and therefore of their dissimilarity with the beings of our own time. However, a greater resemblance is visible, in those epochs which approach the period in which our globe has undergone that disastrous catastrophe, commonly denominated the Deluge. Among the animals existing at that epoch, and those of the present day, there is a much greater analogy. Then, the organized world was composed of beings whose resemblance to the genera at present existing, is more distinct: and on this account, it is reasonable to expect a much greater conformity between living beings, and those fossil remains which are found in diluvian deposits, and in such as had their origin nearly at the same epoch.

As constant as is the relation between the antiquity of strata, and the similarity and dissimilarity of fossil remains with living beings, so much the less, or not at all, does there exist a similarity of climate, between these fossils and those of the living beings which they most resemble. Those which show this resemblance to existing animals, among the herbiferous pachydermata, are the elephants, the rhinoceroses, the hippopotamuses, &c.; and among the carnivorous, the hyenas; all of which exist at present in warm climates. We are then embarrassed by a singular phenomenon, since the remains of these animals are so widely dispersed, both in the old, and in the new world. Their great number, and the circumstances under which they are found, seem to indicate clearly, that they must have lived in the places where their remains are deposited. But this phenomenon is directly opposed to what we see at the present day; for no one of these animals lives in the northern hemisphere, but on the contrary, in the midst of the torrid zone. It seems therefore, that all connexion with climate, is inapplicable to our present subject. Nor are we able to escape the embarrassment of these opposing facts, by admitting a change of temperature at that period: for we find the Russian mammoth provided with a covering perfectly adapted to a severe climate. All that it is permitted for us to say here, is, that these animals have been able to exist in the different countries where we have found their remains. This compels us to suppose that during the existence of these animals upon the earth, there was a climate very different from ours; more uniform, in which they could live and propagate as other animals in their native country.

In admitting this as the most probable reason, it follows as a necessary consequence, that we are not obliged in order to explain the occurrence of these remains in the northern hemisphere, to suppose that they were transported thither by great currents of water; nor have we occasion to calculate the epochs of their transportation; from whence it follows also, we have no farther occasion to go in pursuit of proofs of epochs, drawn from the strata, which, it has been supposed, contain the evidence of them.

Whatever is true in relation to animal remains, must be so likewise with regard to vegetables, of which similar genera live at present, only in warm climates.

Such a proposition, which appears to me very probable, gives a new aspect to the notions which have been formed, respecting this early period, and invites us to enquire into the most probable causes, which might have operated to bring about the phenomena, to which we have just recalled the attention of geologists. More extended researches, and more complete discoveries will place us in a condition to form a comparative fossil physiology, to be added to the comparative anatomy of a similar nature; for which we are indebted to the modern Pliny of France. It is therefore much to be desired that another Cuvier should appear to fulfil a task so important in the natural history of the earth.

Desiderata in Geology.

That some geologist will prepare with care, a systematic description, by means of which we can determine the genera and species to which fossil remains, both vegetable and animal, belong. The materials for such a work exist; but are distributed through a great variety of works; as those of Cuvier and Brongniart, of Parkinson, of Sternberg, of Steinhauer, of Schlottheim and others. As far as I am acquainted, there does not exist a systematic catalogue of this nature; by which we can obtain an exact determination of the species, or by which we should be conducted to a knowledge of their resemblance to the animals and plants of the present day. Such a system would teach us also, which of the classes, orders, and families of organic bodies, present the greatest number of analogies with living beings; and in what proportion the number of the genera and species augment, as the deposits in which they are contained, become more recent.

The author of such a work, should be equally well versed in geology, as in botany and comparative anatomy; for without such an union of knowledge, his work would always be defective in those scientific details and general conclusions, which ought to belong to it.

With the necessary knowledge, he would be enabled to make a just comparison of fossil remains among each other, and with those at present existing in our lakes, rivers, and seas; from which would result the complete determination of the similarity and dissimilarity, which may and ought to exist in relation to this subject.

From his geological knowledge he would be able to distinguish precisely to what extent, the order observed in the superposition of transition, secondary and tertiary formations, is in harmony with those analogies with which the types of the formations present him. By these researches he would perceive if these types succeed each other in a regular manner:—after the graywacke passing through the black limestone of the transition, the sandstone of the coal formation, the alpine limestone, the chalk; from thence to the tertiary gypsum, lacustrine formation; and finally from the diluvial deposits, to those of the alluvion: he would be in a condition to demonstrate whether these types succeed each other in the order which has been adopted in the systems of natural history; in fine, he would be able to classify its different beings according to their structure, which would become a more difficult task, as other systems of organs were added to those already observed.

Such researches, directed by a skillful hand, by a philosophical mind, and a judgment quick, clear and correct, would lead to a solution of the great problem, whether the distribution of organic remains in different strata of the different formations separated by periods, indicates a progressive development of vegetable and animal life upon our globe.

I also hope that such an undertaking may not omit also, the attempt to explain the subject of climates, their relative distribution, in particular, before the catastrophe of the Deluge.

I trust moreover, that the two following questions may be definitely resolved.

1. Ought we to separate a formation, the unity of which has been acknowledged from the relative position, and identity of the beds which are interposed equally through the superior and inferior strata, for the single reason, that the former contain (supposed) fresh water shells, and the latter salt water shells?

2. Is the total absence of organic bodies in certain masses of the secondary and tertiary formation a sufficient reason for regarding these masses as distinct formations, where other geological facts do not justify this separation?

ART. XIII.—*Analysis of an "Essai sur la temperature de l'interieur de la Terre, par M. Cordier, 4to, pp. 84. Lu à l'Academie des Sciences, 4 Juin, et 9 et 13 Juillet, 1827;" With observations; by* THOMAS COOPER, M. D. &c., President of the College of South Carolina.

THE supposition of a central fire is of long standing: it is found in the ancient mythological notions of Pyroplegeton and Hephastos. No wonder. In the early times of the present surface of the earth, volcanos, eruptions of lava, earthquakes, cataclysms, debacles, deluges, were events of frequent occurrence; more so than in our days, when near two hundred volcanos, in a state of activity, serve as safety-pipes to give vent to the gases and vapors generated in the igneous mass below.

"This opinion of a central fire slept, till it became obscurely revived by Des Cartes, Halley, Mairan, Buffon, and others; to whom it was suggested by some or all of the following considerations:

"The figure of the earth; a globe flattened at the poles; pointing to an originally fluid state as necessary to produce it by revolutionary motion.

"Certain astronomical phenomena.

"The mobility of the central mass, producing magnetic action.

"The difference of temperature at the surface and at small depths.

"Experiments on the cooling of incandescent bodies.

"These considerations, however, failed to produce general conviction; and the aqueous fluidity of the globe, a theory advanced by Pallas, Dessaussure, Werner and his disciples, obtained the ascendancy in public opinion. This theory supposes the aqueous liquidity of the whole matter composing the globe of the earth, and its gradual solidification, one stratum after another, from the centre to the surface, by crystallization in water; volcanos being nothing more than the accidental results of peculiar localities.

"This (Neptunian) theory of Werner, has been losing ground from the close of the last century to the present time. It may now be considered as universally abandoned."

It has been found, especially, that the substances ranked by Werner under the denomination of floetz-trap, have so strong an analogy in their appearance, their composition, mechanical and chemical, their position covering indiscriminately all kind of strata, and other circumstances, with known ejections from volcanos, that their igneous formation hardly admits of doubt. That these layers, strata and irregular masses formed over rocks of every age and formation, are often traceable to manifest craters of extinct volcanos; and have, in other cases, so many analogies with known volcanic ejections, that the conclusions as to their igneous nature are nearly irresistible.

"In aid of this last and modern theory, (the Plutonian,) come the experiments on the radiation of caloric into atmospheric space; the communication of caloric from molecule to molecule; and certain mathematical considerations of a general nature; as well as the small distance to which solar heat penetrates into the surface of the earth; and the depth where a fixed temperature has been constantly observed. Late experiments also have shewn, that the temperature of mines and deep cavities uniformly increases as the depth from the surface increases; in proportions somewhat varying, indeed, but calculated on an average at about one degree of the centigrade thermometer for each thirty or forty metres, (ninety-one, to one hundred and thirty-one English feet.)

"Hence, the conclusion has gradually prevailed that the earth possesses a central heat of its own, and an internal igneous fluidity that takes date from the very commencement of the existence of our globe: that the crust of the earth has gradually been hardened by radiation and molecular communication of caloric from stratum to stratum."

How long it has taken to produce this gradual coolness and consolidation of the present crust of the earth, we have not the means of conjecturing in the present state of our knowledge.

"La Grange and Dolomieu were the first who returned to the old theory of central heat. Hutton, and his commentator, Playfair, followed. Lately, M. Fourier, in his Researches respecting the general theory of heat, was led the same way. The subject was also taken up by the much lamented M. de la Place."

The publication of M. Faujas de la Fond on the extinct volcanos of Viverais and Velay, the account of central France by M. Giraud de la Soulavie, and the elements of geology by M. Breislak, have added strength to the modern theory. In England, Mr. Kirwan and Professor Jameson adopted Werner's theory; but Hutton and Playfair, Gregory Watt and Sir James Hall, the disciples of Hutton, Sir George M'Kenzie, Dr. M'Culloch, Mr. Conybeare, and Mr. Scrope, have greatly contributed to change the geological opinions of the British public in this respect. At present the igneous fluidity of the central mass of our earth, and the igneous origin of floetz trap, may be regarded as the settled theories both of the British and continental geologists. Werner seems to have suspected the untenable character of his own opinion as to the aqueous origin of the floetz trap formation, when, being at Paris, he refused the pressing invitations to visit Auvergne.

"If the proofs hitherto adduced in favor of central fusion be sufficient, we ought to consider this theory as fully established: if not, further experiments ought to be instituted that shall set the question beyond reasonable doubt.

"One of the elements of this problem, that which seems to needs further investigation most, is the permanent increase of temperature in descending from the surface towards the centre of the earth. It may be asked, are the experiments, already made, sufficiently exact? Have they been sufficiently examined and criticised as to the manner of conducting them? Are the consequences deduced from them, legitimate and conclusive of the question? Let us therefore, in the first place, examine the experiments which have already been made with this view; secondly, let us give an account of the experiments which we have instituted ourselves for the same purpose; thirdly, let us designate the results and conclusions they afford.

"*On the experiments hitherto made as to subterraneous temperature.*—These relate, to the temperature of natural springs.

"The temperature of natural and artificial excavations: these have been pushed as far as four or five hundred metres, (one thousand six hundred and forty English feet.)

"In France, we possess observations on the temperature of the cave under the Observatory of Paris, during one hundred and fifty years; lately brought to perfection by M. Arago. Those made by M. Gensanne, in the mines of Girmagny, about the middle of the last century; the experiments of M. D'Aubuisson, in the mines of Brittany, in 1806.

"In Switzerland, we have the experiments made by De Saussure, about forty years ago, in the salt mines of Bex.

"In Saxony, we have those of M. M. Friesleben and Humboldt, collected in 1791; those of M. D'Aubuisson, in 1802, and especially those of M. Trebra, in 1805, 6, 7 and 15.

"In Great Britain, we have a great number, from 1815 to the present time; by Messrs. M'Lean, Reed, and W. Fox, in Cornwall and Devonshire; and by Messrs. Bald, Dunn, and Fenwick, in the coal mines of the north of England.

"Nor ought we to omit those made by Humboldt, in the mines of Peru and Mexico, at a former period."*

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* These experiments may all require to be further considered, before the conclusion is permanently established: therefore the authorities cited by Cordier, are inserted here.—*Reviewer.*

Experiments made *in France.* See Dissertation sur la Glace par Mairan. Paris, 1749, in 12mo, p. 60, et suiv. Journal des Mines, tom. 21, p. 119.

In Switzerland. De Saussure, Voyages dans les Alps, 1088.

In Saxony. Ann. de Chim. et de Phys. tom. 25, p. 210. Description des mines de Freyberg, tom. 3, pp. 151, 186, 200. Journal des Mines, tom. 11, p. 517; tom. 13, p. 113. Annales des Mines, tom. 1, p. 377; tom. 3, p. 59.

In Great Britain. Ann. de Chim. et de Phys. tom. 13, p. 200; tom. 16, p. 78; tom. 19, p. 438; tom. 21, p. 308. Geographical distribution of plants, by R. J. Winch, p. 51.

The number of mines subjected to these experiments are more than forty: the number of experiments amount to about three hundred. Many observations of less importance, made not expressly, but accidentally, in mines and caverns of other countries, are omitted. They generally relate to the temperature of the air, and the results are analagous to those made more carefully elsewhere.

It is necessary to examine with much care experiments in a small way, when we mean to draw conclusions from them affecting the heat of the great mass of the globe. Suppose, for instance, the error to be one degree in excess for each one hundred metres, (three hundred and twenty-eight feet,) it would cause in the calculation an error of five hundred metres too near the surface in settling the depth at which water boils.

"With these precautions in view," says M. Cordier, "I made experiments for myself, at the mine of *Littry*, near Bayeux, Department of Calvados, where the shaft opens sixty metres above the level of the sea: at the mine of *Decise*, to the north of the town of that name, in the Department of Nievre, elevated one hundred and fifty metres above the sea: at the mine of *Carmeaux*, Department of Tarn, north of Alby, two hundred and fifty metres above the level of the sea. These experiments were made in 1822 and 1825, with a mercurial thermometer, carefully compared; and with the aid of M. M. Arago and Matthieu, the degrees were all reduced to the centigrade division of the standard at the Observatory at Paris. In the present memoir, the centigrade division has been employed throughout."

M. Cordier then enters into an elaborate investigation of the sources of error, arising from the circulation of air from the bottom of the mine toward the top; from the intermixture of the external air; from the changes produced in the air by the infiltration of water into the mine from above; from the corrections required for the effect of candles, the presence of workmen, and the heat of their bodies and their

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In Peru and Mexico. Ann. de Chim. et de Phys. tom. 13, p. 207.

The British experiments may also be found in their philosophical periodicals, for these twelve or fifteen years past. Some are more, some are less exact. Most of them liable to objections, noted by Cordier, in the progress of the present memoir; but all *tending* to the same conclusion, that *the globe of our earth, under the crust forming its surface, has always been, and now is, in a state of igneous fusion.*

breath. In some mines, all these causes of error exist; in mines long abandoned, very few of them are found; but making every possible allowance, with all the accuracy that the present state of our knowledge admits, the *general fact* of the increase of heat in proportion as we descend from the surface, remains untouched.

From page 10 to page 38 of this memoir, the author is occupied in examining the defects to which former experiments are liable. He reduces many of these experiments into a tabular form; exhibiting the authors, the places, the dates of the observations, the mines, the depths, the temperature of the mine, the mean temperature of the country, and the depth corresponding to an increase of one degree of the centigrade thermometer. On these experiments he makes the following remarks:

"1. The imperfection of the thermometers; from original inaccuracy, and from inaccuracy proceeding from the effect of time on the mercury, and on the bulb. On the necessity of a previous verification of the mercurial scale.

"2. The difficulty of ascertaining the mean temperature of the place. In this, (and indeed in all other respects,) the experiments made in the abandoned quarries under the Observatory at Paris, are more free from objection than any others that have been made elsewhere; they are also more accurate, and longer continued.

"3. Doubts may arise on the absolute depths of the mines subjected to observation. The openings of mines are usually below the medium level of the country.

"4. Observations made on the temperature of springs of fresh water, of artificial fountains, of large streams sufficient to turn a mill at their first exit, may be used, provided care be taken to observe whether they are not influenced by surrounding mountainous regions, and other local circumstances.

"5. The old opinion of the effect of decomposing pyrites, is now abandoned by those who possess the modern geological information. Pyrites is not so abundant any where, even in the roofs of coal measures, as to produce any notable effect: nor is the decomposition of pyrites easily effected, unless they be broken in pieces; for their decomposition proceeds by one surface after another."

He instances this, from the pyrites in the coal mine of St. George Lavencas in Aveyron.

Cordier then proceeds to the conclusions that may reasonably be drawn from the experiments passed under review.

"1. Setting aside some of them, as being too uncertain and inaccurate to be reasoned from, all the others announce, in a greater or less degree, a notable increase of temperature on descending from the surface of the earth towards the interior: this conclusion may reasonably be allowed.

"2. The results collected at the Observatory of Paris, are the only ones which enable us with something like certainty, to express the law of this increase of temperature, viz. one degree of the centigrade thermometer for twenty-eight metres in depth. (That is, 1,8 of Fahr. for about ninety-two feet.) Hence in the locality of Paris, water will boil at the depth of two thousand five hundred and three metres, (about eight thousand two hundred and twelve feet English.)

"3. Very few of the other results furnish numerical expressions sufficiently approximative of the required law, to be of use. These expressions vary from fifty-seven to thirteen metres for one degree (cent.) of increased heat. The mean of them announces an increase more rapid than has usually been admitted. The concurrence of this testimony to the general fact, is of weight, inasmuch as they comprise the result of several series of local observations.

"4. In grouping by countries, the results admissible on whatever title; I incline to think," says Cordier, "that the results collected at the same place, depend upon, and are connected with, not merely the imperfection of the experiments made, but a real irregularity in the distribution of subterranean heat from one country to another.

"The observations hitherto published, possess therefore a real value, efficient and incontestable. But others are still wanting: and I proceed to give an account of those that I have made myself.

"*New and direct experiments on subterranean temperature*, (by M. Cordier.) I preferred coal mines: because the branching excavations are carried to a considerable distance from the shaft: because from the ease of working them, the excavations advance rapidly, and are not so liable to be affected by external circumstances: because it is easy to make speedily and with great ease, deep holes in these mines: in which the temperature can be ascertained free from opposing circumstances. The bulbs of the thermometers in these experiments were enveloped in seven folds of silk paper; so, however, as to admit the degree on the scale to be easily come at. They were kept in a tin case. They were so constructed, that being immersed in melting ice, they took but twelve minutes to descend from 15° cent. to 0°, plunged 5 decimetres in a mass of moistened sand, in a cellar they took twenty minutes to arrive at the temperature of the cellar, losing eight degrees of their initial temperature.

"The first set of experiments, were made at the coal mines of Carmeaux, September, 1825. The mine was 316 metres (1028 feet) deep, with one air shaft. There was a gallery 62 metres long, made about four months past, perfectly dry. The external air was 24°. Hardly any circulation of air took place in the gallery: at 4 decimetres from the ceiling, the air was 23° 6′. A hole was bored in the coal, in a corner of the gallery, 65 centimetres deep, and 4 in diameter, with an inclination of 15°. It took six minutes to make the hole. The thermometer was inserted, and the hole stopped with paper. After an hour, it indicated 19° 5′. The temperature of a well, 11,5 metres (37 3-4 feet) deep, was 13° 15′. The hole in which the thermometer was inserted, was 192 metres (630 feet) from the surface. Hence, 192 metres less 11,5 = 180 metres produced an accession of heat of 6° 35′: about one degree for 28,42 metres in depth. In another experiment at Ravin, there was an accession of 3° 95′ at 170,4 metres deep: or one degree for 43,14 metres.

"The rays of the sun do not produce any appreciable effect; for by the experiments of M. de Saussure they take six months to become sensible at ten metres (thirty-two feet) deep. Voyages dans les Alps § 1423. Annales de Chim. et de Phys. tom. 30, p. 396, by M. Arago. In the cave under the observatory at Paris, twenty eight metres deep, (91,86 English feet,) the thermometer never varies, during the whole year, more than one-thirty-third of a degree.

"In three other experiments made at the coal mine of Decise, one gave one degree of the Cent. thermometer for 15,16 metres; another one degree for 15,52 metres; and another one degree for 14,81 metres. At Littry the accession of heat appeared to be one degree for 19,28 metres."

At Carmeaux, Cordier made ten experiments; at Littry as many; and at Decise the same number. The average accession of heat, was one degree for thirty-six metres at Carmeaux: one degree for nineteen metres at Littry: one degree for fifteen metres at Decise. Average one degree for twenty-three and one-third metres deep. Paris observatory one degree for twenty-eight metres.

M. Cordier, after these details, proceeds to draw the general conclusions which he thinks they suggest. But in this stage of our analysis of this important paper, we think it right to make two or three observations, including a notice of the circumstances which in our opinion he has not sufficiently adverted to.

1. These experiments, some more, some less carefully conducted, those of M. Cordier being the least exceptionable, all lead to the conclusion of the temperature increasing in proportion as we descend into the interior of the earth. But it is a prodigious leap, from these experiments in a small way, to the igneous liquidity of the central mass. Temperature increases one degree for each twenty-eight metres; therefore the centre of our globe is in a state of igneous fusion! Intermediate facts seem necessary before we arrive at such an immense conclusion. So far from denying, we readily admit, the igneous fusion of our planet: but Cordier's experiments on the temperature of mines are not of themselves sufficient to prove it.

Better proofs exist, in the flattening of our globe at the poles, which the latest experiments seem to fix at $\frac{1}{295},5$: a result requiring liquidity. But the most decisive, and in our opinion incontestible proof, is, that glassy obsidian and pumice, half fused cinders, and trachytes, pearl stone, &c. are actually ejected from volcanos in a state of absolute fusion in some instances, and high incandescence in others: and that these fused and red hot ejections are not owing to coal set on fire, as Werner supposed, but are situated far below the coal formation, in the granitic crust; of which, fragments are often ejected. The mass of which these igneous and fused ejections form a part, must itself be in igneous fusion, and incandescent. But this is the central mass below the granite crust.

2. The subterranean heat will depend in some degree on the depth of the strata of which the crust of the earth consists, at the place of observation. Thus, a cavity of twenty-eight metres in the granite, will be nearer the central mass than at a coal mine, or in the surface stratum of the Paris basin, or the London gravel. What allowance ought to be made for these variations in proximity to the central mass, we have no present means of conjecturing beyond the measurements collected by Conybeare in England: but it appears to us, that it forms an element not to be neglected in resolving the problem under consideration. Captain Sabine's observations on the variation of the pendulum look the same way.

3. No allowance is made for the caloric given out at great depths, in proportion as the lower part of the column of atmospheric air is condensed by the weight and pressure of

the superincumbent column. Would not this account for much of the caloric extricated at great depths?

" *On the conclusions deducible from the preceding experiments.*

" 1. The earth possesses within itself a source of heat, not dependant on the rays of the sun: A heat which increases rapidly as we descend deeper.

" 2. The law of this increase of heat is not the same every where. It may be double or triple at one place, what it is at another.

" 3. Nor do these differences depend on latitude or longitude.

" 4. The increase of temperature is more rapid than was suspected. It may rise to one degree at thirteen metres deep in some countries. The average cannot exceed twenty-five metres.

" *Applications of these facts to the theory of the Earth.*

" 1. All the phenomena agree with the mathematical theory of heat; and with a high temperature belonging to the earth itself from its very origin. As the mass of *solid* matter in the earth is ten thousand times greater than the *liquids*, the original liquidity of our globe must have been owing to caloric, and not to water.

" 2. Suppose an increase of one degree for each twenty-five metres (eighty-two feet) in depth, the temperature of our globe at its centre would be thirty-five hundred degrees of Wedgewood's pyrometer, or two hundred and fifty thousand degrees of the centigrade thermometer.

" 3. The temperature of one hundred degrees Wedgewood, sufficient to melt all the lavas, and most of the known rocks, would be found at fifty-five leagues or five thousand metres deep at Carmeaux, at thirty leagues at Littry, and at twenty-three leagues at Decise. Numbers, which agree with 1-23, 1-42, 1-55 of the mean radius of our planet.

" 4. It is probable, therefore, that our earth is a star partially cooled, as Des Cartes and Leibnitz thought: and that the centre still preserves its original fluidity.

" 5. If we consider on one hand the generality which the observations of Dolomieu on the situation of the eruptive fires, (Rapports sur ses voyages Journ. des Mines, tom. 7, p. 385,) and our own (Cordier's) experiments on the composition of lavas, (Recherches sur differents produits volcaniques Jour. des Mines tom. 21, p. 249, tom. 23, p. 55. Memoir sur la composition des Lavas de tous les ages Journ. de Phys. tom. 83, p. 135,) have given to volcanic phenomena—and on the other hand, the great fusibility of the ejected matters of ancient and modern volcanos, we must conclude, that internal fluidity begins in many places at a less depth than where the heat rises to one hundred degrees of Wedgewood.

"6. The crust of the earth, (deducting the superficial and incomplete pellicle called secondary,) being formed by cooling, it follows that consolidation takes place from the outside toward the inside: of consequence the primitive strata, nearest to the surface, are the most ancient. In other words, the primordial formations are so much the more recent as they belong to a deeper level; which is in opposition to the notions of modern geology."

Not so: those who admit the igneous fusion of the mass under the crust of the earth, cannot but admit that consolidation must take place by successive interior layers of the fluid mass, adhering to the inside of that stratum contiguous to it, and already formed; owing to very slow and gradual radiation and molecular communication of heat. This is a consideration that geology has already contemplated, and must at once be allowed; for the formation of granite veins shooting into the gneiss and other superincumbent rocks, can no otherwise be accounted for. So, dykes must be more recent than the disrupted rocks.

" 7. M. Fourier," (Remarques generales sur les temperatures du globe, et des espaces planetaires. Annales de Chim. et de Phys. tom. 27 ann. 1824, p. 326. Et resumè theorique des prorietés de la chaleur rayonnante par le meme: meme tome p. 275,) "in considering the distribution of subterranean heat at accessible depths, the temperature of the poles, and the fact of radiation toward planetary space, has demonstrated that the earth continues to cool. This cooling is not sensible at the surface, because it is compensated almost completely by the heat propagated gradually from within toward the outside; and which fact and theory are fully competent to explain. The loss of heat, therefore, has no influence but at very great depths; whence it results that the crust of the earth continues to increase interiorly by newly formed solid layers. The formation of primitive strata is constantly going on; and will only cease at some very remote period, when the operation of cooling has attained its limit."

These observations will enable us to account for elephants' bones, and fossil plants, seemingly the growth of warm climates, found in Siberia, and other northern regions. Perhaps it may incline us to doubt whether the charming letters of M. Bailly Sur l'Atlantide, are not something more than a philosophical romance.

"8. If the crust of the earth has really been thus formed, the primitive strata, known to us, ought to be disposed nearly in the order of their fusibility. I say nearly, for it ought to have some effect on the rapid action with which the process of cooling took place at its commencement; and of the action also of chemical affinities operating on such immense masses.

"9. Hence, the mean thickness of the crust of the earth does not exceed twenty leagues of five thousand metres, (about sixty-two miles English.) I would even say, that according to some geological data not yet followed out, and to which I shall on some future occasion return, the mean thickness is much less. Abiding by the result above mentioned, this mean thickness would not quite equal one-sixty-third part of the mean radius of the earth. It would be but the four-hundredth part of the ascertained length of a meridian."

M. Pallas somewhere calculates the thickness of the primitive formations at twenty-one miles. In travelling along the main road from Richmond to Charlottesville, in Virginia, the reviewer of this paper and Mr. Vanuxem noted, as well as we could, the distances at which the strata changed, from the granite at Richmond, to the disappearance of the primitive; and we thought the primitive strata, thus passed over, could not be less in thickness than forty miles, making the usual allowance in calculation.

"10. It is probable that the thickness of the crust of the earth is very unequal. This seems to follow from the increase of subterranean temperature from one country to another. Difference of conducting power, is not alone sufficient to account for the fact. Several geological data tend also to the same conclusion.

"11. The heat proper to the soil of each locality, and thence gradually disengaged, being the fundamental element of the climate of that locality (?)—and as in our opinion, (M. Cordier's) the quantity of heat disengaged is not in any constant relation between one country and another, we may conceive how, ceteris paribus, countries in the same latitude may have different climates; and how Mairan, Lambert, Mayer, and other philosophers have failed, when they sought to represent by formulæ the gradation which the mesne superficial temperatures follow, from the equator to the pole; and which they presumed to be regular. We have contributed here a new cause, in addition to those which occasion the singular inflexions exhibited by isothermal lines.

"12. Whatever may be the nature of the forces, or the astronomical events, which have anciently troubled the stability of continents, and produced that general dislocation and overturning which the crust of the earth exhibits, we may easily imagine that all the parts of this crust floating on a fluid mass, and infinitely subdivided by stratification, and above all by the innumerable contractions which cooling has produced in each layer, may have been dislocated and overturned as we actually see has been the case. These effects are inexplicable on the usual supposition of the external strata of the primitive having been last consolidated, and the globe being solid to its centre.

"13. On considering the probable fluidity of the central mass, the phenomena of earthquakes, the trifling thickness of the consolidated crust,* and, above all, the innumerable solutions of continuity which divide the crust of the earth, and which result either from stratification, or from the contraction which takes place during progressive cooling, or from the overturnings which the strata have experienced, we long ago were induced to acknowledge that the crust of the earth possessed a certain degree of flexibility. In a memoir read at the Academy in 1816, we developed the elements of this singular property: but that memoir had the misfortune to be presented at a moment when the public mind was not sufficiently prepared to attend to these kinds of speculation. This flexibility becomes now more probable than ever: we may now conceive moreover, in consequence of the fluidity of the central mass on which this crust reposes, how this flexibility may be affected without our being sensible of it. In fact, to bring about a change of figure in the spheroid capable of elevating the equator one metre, it would be sufficient in relation to the plane of the equator that each of the innumerable solutions of continuity which intersect transversely the solid crust, and which I shall suppose to be five metres separated from each other on the average, should undergo a separation equal to the 1-1276 part of a millimetre: a quantity extremely small.

"14. The probable flexibility of the crust of the earth is actually confirmed by two principal causes: the one general and continual; the other local and transitory. This last cause, considered during the last thirty centuries which have elapsed, has spared no region of the earth. Sometimes it has shaken almost at the same moment the twentieth part of the continents; or else it has produced an undulation in directions equal to the sixth or seventh part of a meridian. I allude to earthquakes. Since

* About the one-one-hundredth part of the semi-diameter of the globe, assuming the primitive to be forty miles deep.—*Reviewer.*

the (brief) period when history commences," (and when the diminution in the number of earthquakes at length permitted the earth to be habitable,) "we may count six hundred earthquakes remarkable for violence or extent. The second cause depends upon this, that the permanent diminution of the heat of the earth, no longer produces any sensible contraction in the subterranean regions near to the surface, while its effects still take place in the interior; either augmenting the distance between the masses which have undergone the first effects of contraction, or producing new solutions of continuity in the masses. We may add, that the slow formation of new strata in the interior must be subordinate to the general law, by which liquids contract in bulk on becoming solids.

"15. The less flexible portions of the earth's crust, are those nearest the surface; for the transverse solutions of continuity in them have long ago acquired and lost their maximum of separation. It is evident that the central forces tend to bring nearer together the elementary masses of the surface, in proportion as cooling contracts more and more the bulk of the interior. This process of approach would act uniformly if the layers of the consolidated crust were concentric; and if all the transverse solutions of continuity were found in planes perpendicular to the surface. But it is not so. The state of overthrow of the primordial crust is such, that, considered in its full extent, I can only describe it as a mass of fragments pressing sideways against each other, whose layers are all either vertical or much inclined. Since this state of things took place, the obliquity of solutions of continuity out of number, some of them of prodigious extent, forbids such an approach of elementary masses as shall be uniform, and proportionate to the central contraction. This approach has been replaced by alterations of level, slight indeed, but sufficient to affect continental surfaces of great extent. Many geological facts agree with this hypothesis. We may take for granted that the effect still subsists, although insensibly. If the secular rise of the basin of the Baltic is constant, it may be explained upon our supposition. In the same way we can account for the change of level in the Mediterranean, which we observed in company with Dolomieu, on the shores of Egypt. (See Description des ruines de Sân (Tanis des anciens) dans le grand ouvrage sur l'Egypte.) According to our notions, all that part of the continent of Africa experiences a depression equal to two or three centimetres every century."

The other facts of oceanic retrocession collected in the book entitled "Telliamed," and elsewhere, may be accounted for in the same way.

"16. M. de la Place, regarding the astronomical facts observed in the time of Hipparchus, as sufficiently exact to conclude that the duration of a day has not diminished 1-300 of a centesimal second in two thousand years, thought, that the contraction actually produced by the secular cooling of the globe was not sufficient to increase the velocity of its rotation. This opinion suggests an useful limit to the actual effect of general cooling.

"17. But if we consider the effects of contraction from the commencement of the cooling process, we must admit that some influence in this last respect has actually been exerted. On the one hand, the duration of the day has very slightly been diminished, and, on the other hand, the figure of the earth has been slightly altered in consequence of the increased velocity of its rotation; provided the flexibility of the earth's crust has been sufficient to endure this alteration of figure; which we admit. The day therefore is actually shorter, and the flattening at the poles greater than at the first origin of things. If these data be conceded, the two effects just mentioned are still going on. It remains only to find some better means of calculating this weak intensity; which is not impossible, as we shall see by and bye.

"18. Another consequence, not less probable or curious, to which we are led by the theory of the incandescence and igneous fluidity of the central mass, is this. If the flexibility of the earth's crust be such as we have supposed, the phenomena of tides take place in the crust of the earth itself. We shall not be surprised at this effect, very feeble though it be, if we pay attention to the fact that it certainly did take place at the origin of our globe, and while it was in the perfectly fluid state which *all* hypotheses admit. It would be easy to show that the highest of these ancient tides did not rise less than four or five metres.

"19. The secular refiguration, continually increasing the thickness of the earth's crust, gives room to inquire, whether the incandescent matter submitted to this action passes entirely into a state of solidity, or whether the production of gaseous substances does not accompany the process. So far from this being impossible, the daily coagulation of lavas offers a striking example. This supposition explains very naturally the origin of the first material cause of earthquakes. An excessive temperature keeps this first material cause in a gaseous state, notwithstanding the influence of immense pressure at the depth we are now considering. The capricious phenomena, earthquakes, may depend also on the great inequality of the interior surface of the crust of the earth.

"20. These data lead to a new explanation of volcanic phenomena, which, to the very few persons who have a just notion of the elements of this question, may appear more satisfactory than any heretofore suggested. These phenomena appear to us a plain and natural consequence of the cooling of the interior of the globe—a mere thermometric effect. The internal fluid mass is submitted to an increasing pressure produced by two forces of immense power; although the effects are slow, and scarcely sensible in their gradual operation. On the one hand, the solid crust of the earth contracts more and more as its temperature diminishes," (from radiation on the outside, and molecular communication internally.) "This contraction is necessarily greater than the central mass experiences at the same time. On the other hand, this envelope, in consequence of the insensible acceleration of rotatory motion, loses its interior capacity in proportion as it recedes from a spherical shape.

"The interior fluid substances are compelled to flow outward in the form of lavas by the process which we term volcanic, and with a precedent production of gaseous matters produced internally during eruptions. Let no one be surprised at this hypothesis: I can render it probable by a very simple calculation.

"At Teneriffe, in the year 1803, I took as near as possible the cubic dimensions of the ejected matters of 1705 and 1798. I did the same by two eruptions more perfectly insulated in the interior of France; in 1806 those of the volcano of Murol in Auvergne; and in 1809 those of the volcano of Cherchemus near Izarlès at Mezin. I found each eruption to have ejected less than a cubic kilometre. On these facts, and others of the same kind which I collected elsewhere, I feel authorized to consider the cubic kilometre as the extreme general term of bulk of volcanic ejections. This is very small, compared to the whole globe. Spread over its surface, it would not be one hundredth of a millimetre in thickness. In exact terms, suppose the crust of the earth to have a thickness of twenty leagues of five thousand metres each, (fifty-seven miles,) a contraction that would shorten the mean radius of the central mass 1-494 of a millimetre would suffice to produce an eruption."*

"Proceeding from these data, if we suppose that contraction alone will suffice to produce the phenomena, and that five eruptions annually take place over the whole surface of the earth, we find the difference between the contraction of the consolidated crust and that of the fluid mass to shorten the radius of that mass but one millimetre in a century. If there be but two eruptions annually, the same shortening will take place in two centu-

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* Kilometre 109364 yards English in length. A cubic kilometre is about two and a quarter million of cubic feet English. Millimetre ,03937 cubic English inches.

ries and a half. It is clear that, in all cases, a very minute action suffices to produce the phenomena.

"It will be remarked that this action, if it be real, is necessarily connected with the whole contraction which the globe undergoes from the effect of secular cooling. It furnishes a basis for calculating the very weak influence which this total contraction exercises in accelerating the velocity of rotation.

"Nothing less than this enormous power which I have described, is required to raise lava. In the particular case where lavas come from a depth of twenty leagues, it is easy to prove from their mean specific gravity, that they would be pressed with a force equal to twenty-eight thousand atmospheres. We know moreover that they overflow after an eruption of gaseous matters, which may well be the case on my theory of the subject.

"This is not the place to develope the hypothesis purely thermometric, which I propose in explanation of volcanic phenomena; and to shew how well it applies to all their details. It will suffice to observe that it assigns a reason for the identity of the circumstances which characterize volcanic phenomena every where, of the prodigious reduction in the number of volcanos since the origin of things, of the diminution in the quantity of ejected matters at each eruption, their nearly similar composition at each geological epocha, and the small difference that appears between ejected lavas of different epochs. In short, in this hypothesis, the most usual direction of earthquakes announces the zones where the crust of the earth is thinnest; and the volcanic centers, ancient and modern, point out the thinnest and least resisting portions of this crust.

"In my preceding remarks, I have left uncalculated the gaseous matters which are produced at each eruption; for supposing them reduced to their primitive state of liquidity while in the mixture from whence they have been disengaged, they would occupy but little bulk; and the medium I have adopted, of a cubic kilometre, is much beyond the actual volume of ejected lava."

The suppositions of M. Cordier in this paragraph seem too gratuitous. We have as yet nothing that approaches to proof of the primitive formations (limestone, talcose rocks, clay slate, mica schist, hornblende rock, the gneiss to which all these seem subordinate, and the older small grained granite whereon the gneiss usually reposes,) being from forty to sixty miles thick. No accurate measure of their edges and angles has yet been taken. As yet, all is conjecture. That a lava should require for its ejection the force of twenty-eight thousand atmospheres, is neither probable from any facts known at present, or likely to be made so. There is *no* proof that the crust of the earth admits of no vacuities between itself and the fused mass. There is no proof of its being every where in contact with the fused mass. The phenomena of earthquakes and volcanos indicate continuous cavities of prodigious extent. The earthquake of Lisbon, 1755, which shook all Europe and part of Africa, took a fortnight to travel across the Atlantic, and four hours between Philadelphia and Boston, as appears by the letter of Cadwallader Colden, in Phil. Trans. for 1756. There is no accounting for this, but by means of continuous cavities between the consolidated internal crust, and the fluid mass beneath it. The rumbling noise under ground, attending earthquakes, indicates hollow places. There is no sufficiently probable evidence, beyond Cordier's peculiar notion, that the slight contraction of the consolidating crust can act upon the whole central mass of the globes, especially if it be, as it probably is, elastic. All Cordier's most ingenious hypothesis (for theory it can hardly be denominated) *may* be true, but it wants farther proof that it is so. The action of steam, and the explosion of the gases of decomposed water, seem, to us, as yet the most probable cause of volcanic eruptions.

"21. The greater part of the substances which mineral and thermal waters contain, being analogous to the exhalations from craters during and after their eruptions, or from lava-currents during crystallization, or from solfaterras, it is reasonable to conclude that they proceed from a common source. The emissions from these waters, lessen continually the interior charge of gaseous matter. This loss, continually repaired by new subterranean products, takes place in consequence of a prodigious expansive force, and by means of very narrow fissures. The water is supplied from above, as springs usually are. The alteration of certain parts of the conducting fissures occasions the substitution of certain principles by others. In this system of explanation, we recognize easily the permanence of the springs, their nearly invariable temperature, and the singular nature of their principles. Many circumstances lead me to think that these thermal waters were more abundant anciently than now, which may be the consequence of the greater thinness of the crust of the earth formerly, and the greater activity of the process of cooling."

These observations apply to many of the warm springs in the United States, which yield sulphur, and sulphuretted hydrogen: but to very few in England, except Harrowgate, and two or three others.

"22. If we judge from the lavas, the fluidity of the incandescent matter which constitutes the interior of the earth would be very great; and its density in places distant from the center, as $\frac{49}{50}$ of the radius, would be much inferior to the mean density of the whole globe." (The density will no doubt be in a certain degree the result of superincumbent pressure.) "These two data are not in opposition to the influence which we must allow to the enormous and increasing pressure ascribable to the central forces. It must however be remembered that liquids are not easily compressed; that this compressibility must have a limit; and that excessive heat may counterbalance its effects. Moreover, lavas actually have a greater mean specific gravity than that of primitive rocks in general: whence we may conclude, independently of any other consideration, that the density of the central substances depends more on their nature, than on the compression they undergo. They have been arranged originally in the order of their specific gravities. The existence of gold and platinum proves that matters of very great specific gravity may be found at the center of the earth."

The obsidians, the pumice, the pearl stones, the volcanic cinders, the trachytes generally, do not possess a greater specific gravity than the average of the primitive rocks. Other lavas, containing a notable proportion of iron, do. We have no proof of the existence of metallic substances near the center of the earth in particular. Gold and silver are found mostly in the primitive and early transition rocks. So are tin, titanium, scheelin, and metallic iron, which could not have been deeply placed in the central mass.

"23. There is some likelihood in the hypothesis of M. Halley, which ascribes magnetic actions to the existence of an irregular mass chiefly composed of metallic iron, and having a peculiar revolving motion at the center of the earth. Two kinds of phenomena, of which Halley was ignorant, add to this probability. One is, that the rotation of Saturn's ring round that planet, may be called in as furnishing a kind of analogy: the other, that the nature of meteorolites, and the existence of meteoric iron, prove that iron in its metallic state, and alloyed with nickel, may enter abundantly into the composition of planetary masses."

The mass of Siberian iron, that in the Lyceum at New York, the mass said to exist near the Mandan village, the masses in the Pampas between Buenos Ayres and Chili, may be cited in addition. But what shall we say of the numerous masses of metallic copper in the talcose district of Lake Superior, which are partly described by Mr. Schoolcraft? Are they not also meteoric? If they be, Cordier's argument may prove too much.

"24. If Halley's hypothesis be admissible, it suggests a limit to the interior temperature of the earth. This limit is the resistance which forged iron subjected to enormous pressure opposes to fusion. We might be tempted perhaps to reduce this temperature, on considering the experiments of Newton confirmed by Barlow, which prove that iron at a white heat loses its magnetic virtue. On the other hand, we must not forget that an excessive compression of the metal is likely to retard the limit where the magnetic virtue is thus destroyed.

"25. In fine, in adopting this hypothesis, we shall be justified in examining some very feeble effects, secular, and not hitherto perceived, which the various positions and irregular figure of an interior solid mass, possessing a peculiar motion, and partly composed of metallic iron, might occasion. For instance, we should be led to doubt the perfect and absolute invariability, which we have hitherto ascribed to a plummet line in every place: this doubt would extend to countries situated far from the bands or zones without declination, and from the magnetic equator.

"Such are the principal deductions to which we are led by introducing the hypothesis of heat and central fluidity, in the midst of questions of the highest importance to geology. It would be easy to extend these inductions; and to explain for instance in a satisfactory manner the formation of primordial, unstratified rocks, those of the intermediate (transition) districts, veins, gypseous, sulphurous, saline, calcareous and magnesian strata of the secondary class. The fecundity of application is remarkable; and tends to prove the probability of the theory. This would not be the case with the Neptunian hypothesis, which has reigned so long, and which represents our globe as a mass solid even to the center, cold, inert, and formed throughout of aqueous depositions.

"This system has remained barren; and no part of it will now bear an accurate examination. It is now reduced to narrow limits, to the explanation of those superficial layers formed of consolidated sediment, conglomerated fragments, and organic remains, which form, almost entirely, the very thin covering which is called the secondary set of formations. Had not the authority of the scientific men who brought this Neptunian system into credit produced an illusion, it would long ago have been subjected to the very simple proof which it could not have resisted, viz. the comparison of the masses of water with the earthy and metallic masses which enter into the composition of our globe. It would be easy to establish that the weight of the whole mass of water, does not exceed a fifty thousandth part of the weight of the whole globe. Acuate the solvent power of this aqueous fluid as you please, it is impossible to make one kilogramme of water dissolve fifty thousand kilogrammes of earthy and metallic matter.

"We must be permitted to say, that we have not been brought back to the theory of a central fire by any spirit of system, but in opposition to system, and in spite of prejudices. The force of fact has produced this change of opinion; it results from considerations carefully reflected on, and from phenomena of a very different order. Above all we cannot believe that it is by mere accident that natural philosophy, astronomy, and geology have arrived at the same point by such different routes. We may therefore without hazard assert that an hypothesis equally necessary to all these sciences seems to put on the characters of a real and fundamental principle; and we may expect it will, by and by, have as happy an influence on the theory of the earth, as the great principle of gravitation has had on the theory of planetary motions.

"At this point of our knowledge, it should seem that the Academy ought not to remain a stranger to so great a question. Perhaps it is now time to follow up a measure proposed on the 28th November, 1825, by M. de la Place.* Perhaps it would be proper also to engage the coöperation of all our scavans by distributing the elements of the question as subjects for prize. The Academy was occupied during the whole century in determining the figure of the earth. An investigation of the principle that presides over the structure of our globe, and governs all the phenomena belonging to it, is not less worthy of the efforts of the Academy, nor beneath the means at her disposal. The end proposed is certainly among the grandest upon which hnman ingenuity can exercise itself; and success would be interesting to the whole body of science. If the earth be not that inert mass which it has long been supposed to be, if the appearance of inertia be solely ascribable to the slow development of the phe-

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* The proposal was, to name a committee of six members, Messrs. La Place, Arago, Poisson, Thenard, Gay Lussac, and Dulong, to draw up a programme of experiments to be executed: so that the Academy might determine by exact experiments—1. The state of the magnetism of the earth. 2. The pressure and composition of the atmosphere. 3. The heat of the globe, at different depths.

nomena, and the weakness of intensity in their progress; if every thing in the interior is at work, as every thing is on the surface, we arrive at a most important result; since the remark is also applicable to the whole planetary system; and thus we obtain a proof of the most powerful kind, of the existence of the great principle of *universal instability*, which was announced or perceived by Newton and other philosophers.* A principle superior to all those great rules which we have been accustomed to regard as constituting exclusively the Laws of Nature. By the aid of this principle, we look beyond the most distant periodicities, which have hitherto been regarded as the most perfect portions of our solar system. A principle that seems to govern the universe to its minutest atom; which modifies incessantly all things; which alters and displaces them, insensibly and without return; and which forces them along with it through an immensity of ages, for new purposes which the human understanding is incompetent to fathom, but of which it may feel proud to have exhibited the necessity."

Such is the substance of M. Cordier's most interesting paper. The Neptunian hypothesis was in articulo mortis before he wrote; it is now consigned to the resting place "of all the Capulets," never to be revived.

Many difficulties remain, on Cordier's hypothesis, which he will have to account for. If the cooling of the mass began with the sienites, next to the transition series, thence to the limestone and talcose rocks, then to the clay slate, mica schist, and gneiss, why are not these rocks found composing the highest peaks and eminences, instead of the oldest granite, and porphyry? though indeed the latter is found in company with the sienite nearest the transition. The period of the conversion of steam into oceans and rivers, the average depth of the ocean hardly yet settled by astronomers, the great probability of earthquakes being either the effect of steam, or the explosion of oxygen and hydrogen from decomposed water, and many other circumstances, yet remain to be explained. When I have leisure to compare the notions of M. Cordier with those of Mr. Scrope, you may perhaps hear again from Your obedient servant,

THOMAS COOPER.

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* The ancients entertained an opinion that all things were in a perpetual flux.—*Reviewer.*

REMARKS.

A correspondent inquires, is it not possible that Cordier may have deduced untenable conclusions from his own experiments? By numerous trials, he seems to have shewn, that if a point be assumed at the greatest depth to which solar influence penetrates, the heat increases upwards and downwards from that point. He assumes the increase of heat to the depth of a few thousand feet as the ratio of increase to the centre of the earth. By this principle of calculation, he infers that all the interior of the earth is in a state of fusion, at a depth considerably less than one hundred miles. But if the earth was, at the beginning, highly heated throughout, would it cool in that uniform ratio assumed by Cordier; so that the remaining heat may be represented by a four-sided pyramid whose sides are isosceles triangles? Ought not the remaining heat to be represented by a four-sided pyramid whose sides are the areas of Gothic arches with sides nearly parallel towards the base? The latter would certainly be the true figure for representing the remaining heat of a red hot cannon ball, after it had been suspended by a chain, until its superficial heat should be so far reduced that it could be borne by the hand. According to this method of calculation, the increased temperature demonstrated by Cordier's experiments, would not require the greatest heat, even at the centre of the earth, to be above the red heat of iron.

NOTICE.

Before closing this article, we deem it proper to mention, that a translation of the entire essay of M. Cordier, (in the form of a neat pocket volume,) has just been handed to us. It is from the Junior Class at the College of Amherst, who, under the direction of the able and active Professor of Chemistry, Mineralogy, &c. in that institution, have favored the American public with the whole of this singular and interesting production. As far as we have been able to observe, the translation is executed with fidelity and in good taste, and will, we trust, command the attention of those who are disposed to inquire into the physical condition of the interior of our planet.—Ed.

Art. XIV.—*A Description of the Mineralogy and Geology of a part of Nova Scotia; by* Charles T. Jackson *and* Francis Alger.

(Continued from Vol. XIV, p. 330.)

Before describing the capes and islands of trap rocks which project into the Basin of Mines, or are scattered along its northern coast, forming the outskirts of the North Mountain range, and the limits of this interesting formation, it will be necessary to give a brief account of the situation and extent of this sheet of water. The Basin of Mines is a scalene triangular shape, and its longest side being formed by the township of Parsborough and the district of Colchester on the north is sixty miles in length. The next side, which is forty five miles long, is formed by the county of Hants; and its shortest by the county of Kings, for the distance of twenty five miles. The greatest breadth of this basin is from Windsor to Parsborough thirty miles. It communicates with the Bay of Fundy by a narrow, but deep strait called the "Gut," which passes between the majestic walls of Cape Split and Cape D'Or.

This basin will prove interesting to the traveller, not only on account of the delightful villages seated on the banks of some of the many rivers which empty their waters into it, the picturesque and imposing scenery on its borders, and the enormous tides which here rise to the height of sixty feet with fearful rapidity, but also for the remarkably fine illustrations of the geology of the country and the interesting relations of the different formations, which are here presented in an unusually distinct manner. The geologist will delight to circumnavigate the whole extent of its coast and explore the connexions of the different series of rock formations, the highly curious and important junctions of the trap with the sand stone, shale, &c. The collector of specimens in natural history will also be richly rewarded for the perils to which he may be exposed, by the acquisition of many of the rare and beautiful productions of the mineral kingdom.

The most eligible, and only efficient mode of exploring this coast, although not free from danger, is by means of a boat, not so large as to be incapable of being rowed in case of failure of wind; for, besides the difficulty of transporting specimens, the traveller is constantly in danger of being caught, beneath the insurmountable precipices, by the rapid influx of the tides. An accident of this kind having nearly happened to ourselves in examining the geology of Cape D'Or, where we were under the necessity of making our escape by clambering up a mural precipice three hundred feet high, which was effected with great risk of falling with the detached columns on which we depended for support, we think it our duty to warn our successors of such hazards, and to recommend a boat as the ark of safety in such emergencies.

The trap rocks form the extremities of Cape Chignecto, Cape D'Or, Cape Sharp and most of the islands scattered along the northern coast of the Basin of Mines. As each of these places exhibits some interesting geological phenomena, and furnishes many specimens of minerals of remarkable beauty, we shall describe them in order, beginning at the mouth of the basin and proceeding eastwardly along its northern shore.

Cape Chignecto, although it is not situated within the basin, can be more conveniently described here than elsewhere. It is connected with Cape D'Or and projects to the west from it into the Bay of Fundy. This cape was seen only at a distance by ourselves, but the craggy precipices clearly indicated its composition to be of greenstone trap, like the adjacent cape, next to be described. This surmise has since been confirmed by the examination of its structure by our friend Dr. Benjamin Lincoln, who has kindly communicated to us many facts relating to the geology of the county of Cumberland.

The trap forming the extremity of Cape Chignecto, which is the southeastern limit of the county of Cumberland, extends back into the county nearly to Apple River, where it meets the sandstone hereafter to be described, and terminates abruptly; the sandstone coming boldly into contact with the trap, and not dipping beneath it as usually happens. The strata of this rock are nearly horizontal, and Dr. L. suggests the probability of a fault existing in the strata at this junction. This cape deserves a more attentive examination to determine if this be true, as it must have an important bearing on the theory of the origin of trap rocks, and would lead to the opinion that the weight of this superincumbent rock had caused the fragile sandstone to yield to its pressure and thus accomplished the dislocation of the strata.

The next place to be described was the subject of our own examination; and from the great variety of its productions, deserves the particular attention of the mineralogist.

Cape D'Or, situated at the mouth of the Basin of Mines, presents a mural precipice, attaining, in some places, an elevation of four hundred feet above the level of the sea; and is composed of amorphous and irregularly columnar trap, resting on amygdaloid and brecciated greenstone or trap tuff. From the yielding nature of the two last mentioned rocks, which form the base of the precipice, deep caverns and irregular arches have been formed beneath the superincumbent rock, by the beating of the angry surges against the walls, while a shelving platform of trap tuff remains below the surface of the water, and running down beneath the waves, is left exposed only by remarkably low tides. This trap tuff is a breccia composed of angular and irregularly rounded masses of compact greenstone, amygdaloid and red sandstone, united by a softer cement of the same substances. The sandstone at this place occupies but a small proportion of the breccia. The crevices in this rock are frequently occupied by irregular masses of native copper, which generally are indented by the surrounding matrix. They are rarely arborescent, and never distinctly crystallized. Where exposed to the action of the waves, the copper is always bright, and may be seen for some distance beneath the water; but, where it is beyond their reach, it is usually coated with an incrustation of the carbonate or oxide of copper. The individual pieces seldom weigh more than one or two ounces, but masses are said to have been found lying detached among the fragments of rock, one of which weighed fifteen pounds. The name of this cape doubtless originated in the supposition that this metal was gold, and was bestowed by the French emigrants, who were the first Europeans that peopled Nova Scotia. The brilliancy and unusually yellow color of this copper might easily have caused this error, as it led us to suspect it might be an alloy of that or some other metal;—but on chemical examination it was found to dissolve entirely in diluted nitric acid, and gave no precipitate when tested with muriate of soda, or when largely diluted with water, or when treated to excess of saturation with aqua ammoniæ. It does not contain, therefore, any gold, silver, antimony or iron, the only metals suspected to be present. The copper is confined, exclusively, to the brecciated and amygdaloidal trap and never occurs in the superincumbent columnar rock; hence the absurdity of excavating shallow pits into the soil, crowning the summit of the precipice formed by these rocks, in search of this metal, since it exists nearly three hundred feet beneath; this was done by the miners under the direction of an agent from a London mining company, the year before we visited the cape. Large sums of money were expended in this random method of mining, which it is not necessary to add was entirely fruitless, as must ever be the case with such processes when unaided by the light of science; and the project of mining at this place was altogether abandoned. The copper being scattered through the trap tuff, and not collected into any regular vein or bed, renders it highly probable that this metal will never be advantageously explored at this place, and as it occurs chiefly below the level of high water, the shafts would be liable to be filled at the periodical influx of the tide, if indeed the works were not entirely demolished by the violence of the currents. The sanguine expectations excited by the appearance of this metal, in a state of purity, must then be disappointed.

Masses of calcareous spar, and crystals of analcime, tinged green by the carbonate of copper, and having slender filaments of copper enclosed in them, occur in the cavities of the amygdaloid which rests on the trap tuff.

On the eastern side of Cape D'Or, the precipice assumes a concave form, and has received the characteristic appellation of Horse Shoe Cove. Here the cavities in the amygdaloid are of greater dimensions, and are frequently occupied by crystals of transparent analcime, which are grouped together, in congeries of large and small crystals.

Calcareous spar here occurs in long slender hexahedral prisms projecting into, and intersecting the cavities. They are curiously interwoven with each other, and are richly encrusted on their surfaces with small but perfect crystals of stilbite. The specimens are very prepossessing in appearance, and would, from their resemblance, be mistaken for the crystallizations of sugar, which adorn the shops of our confectioners.

The stilbite occurs, also, in radiating groups of crystals, forming beautiful stellæ, which are distributed through the enveloping masses of calcareous spar.

Many other minerals occur at Cape D'Or, but as they are such as we have already noticed as occurring at other places, we shall not here repeat the notice of them, as it is our object to describe only those which are peculiar to the place, or which possess singular beauty, or present remarkable phenomena.

Grey oxide of manganese is said to have been found here, and it is mentioned in Cleaveland's Mineralogy, p. 673, on the authority of Mr. Thayer. We were however unable to discover this substance, or any thing indicative of its presence.—Possibly, the occurrence of magnetic iron ore on this cape, may have occasioned an error in quoting it as a locality for manganese, as the inhabitants have mistaken this substance for manganese, or as they call it "*Magnus*," and formerly sent it, as that article, to the U. States for sale.

Leaving Cape D'Or, we pass Spencer's Island, which is situated about a mile from this cape. It is composed of columnar trap, and adds much to the picturesque scenery of this region, although it presents no objects of natural history worthy of a description. The altitude of this island considerably exceeds the diameter of its base, and standing alone, like a tower in the midst of the waters, it breaks in a degree, the violence of the surge, which rolls into the Basin of Mines from the Bay of Fundy.

Proceeding along the coast towards the east, up the basin we pass the more tame scenery of the sandstone and shale districts to be described hereafter, and do not observe any greenstone trap, until we arrive at Cape Sharp, which is fifteen miles from Cape D'Or. The promontory of this cape is composed of the amorphous trap which scarcely exhibits any traces of columnar arrangement. The trap forms a precipice or "bluff" which exhibits a remarkable contrast to the low sandstone hills with which it is connected; and standing between them and the sea, serves to protect them from its ravages. (See Plate I.)

This cape will not furnish the collector with any mineral specimens of interest; but as this was the first place where the junction of the sandstone, shale and trap were observed, it deserves honorable mention on account of its geological interest. The sandstone and shale, which will be particularly described hereafter, are seen at this place to dip beneath the trap, at an angle of twenty or thirty degrees, and in their passage, are observed to become singularly altered in appearance. The strata of these substances, before regular and distinctly parallel, are found altogether broken up

PL. 1

Pendletons Lithog.y

from nature by C. T. Jackson

CAPE SHARP

From Partridge Island bearing North West 5 Miles.

1. Strata of sandstone & shale dipping beneath the trap. 2 Junction. 3 Columnar trap

and lying confusedly in various directions; the sandstone has changed to a dark red color, is more compact, and has become intimately blended with the shale, so that the eye with difficulty distinguishes the substance peculiar to each. The sharp angular fragments of the trap are next observed, and the whole becomes a distinct breccia, growing more compact as it dips beneath the superincumbent rock. That portion of the breccia in contact with the trap exhibited the small cavities of vesicular amygdaloid, as it passed into its dominion, and led us to believe that the shale and sandstone combined with the trap, and produced amygdaloid by their union. The numerous instances in which this occurred, as it did in fact at every junction of these rocks in Nova Scotia, and the absence of trap tuff and amygdaloid in places where this did not happen, or where, although the sandstone, &c. were not visible, it could fairly be inferred to exist beneath, led us irresistibly to this conclusion. That this process was attended by heat is inferred from numerous circumstances, a few of which can be mentioned here, and others in treating of the two great divisions of the country which remain to be described. The occurrence of native copper in the trap tuff and amygdaloid, may be regarded as evidence in favor of this; the conversion of claystone into fine red jasper, as it entered the superincumbent trap; the cylindrical cavities in the amygdaloid at St. Croix Cove; and even the existence of vacant spheroidal cavities may be considered as internal evidence in favor of this theory. The change of color in the sandstone from grey to red, and the compactness of the strata as it approached the trap; the absence of organic remains, and the charred state of the vegetable remains in the neighboring strata, give sufficient evidence, that, during the formation of the secondary trap in Nova Scotia, there was considerable heat. The sharp fragments of the breccia, and the breaking up of the strata, also shew, that the production of this rock, or rather its non-conformable position on the sandstone strata was effected suddenly. Whether it was ejected from the inaccessible depths of the Basin of Mines, or was thrown directly up through the strata of sandstone, we cannot determine; but the occurrence of the trap only on the borders of the basin which it almost surrounds, would lead us to the belief that this cavity was the crater, if it may be so called, from which, in former times, the trap rocks issued. The same remarks will apply to the whole North Mountain range, except that they probably originated from the unfathomable depths of the Bay of Fundy, which is completely skirted, on either side, with trap rocks.

If we were biased in favor of any theory of the earth, when exploring these formations, it was for that of Werner; and becoming satisfied of the insufficiency of the Neptunian method in accounting for the phenomena observed in the North Mountains, and the appearances assumed by the neighboring strata, we were induced to allow the superiority of the igneous theory, as taught by Hutton, Playfair, and Daubeny.

In treating of the South Mountains, we shall perceive the necessity of an amalgamation of both theories, to explain the relations of that range to the North Mountains.

Partridge Island, situated near the village of Parsborough, and six miles from Cape Sharp, is the next place to be described. In crossing the Basin of Mines, after passing the majestic Blomidon, this island is the first elevated object that meets the eye. It consists of amygdaloid and columnar greenstone, which, on its south-west side, presents a precipitous and overhanging front of about two hundred and fifty feet, rendering precarious the situation of those who may pass beneath its brow. Stationed near the verge of this precipice, the visitor beholds beneath him rugged, insulated towers rising abruptly from the sea almost to a level with his own standing, and having withstood the frequent commotions of the sea, which during the stormy winter months is thrown among them in the most frightful billows, yet remain as firm and immoveable barriers to resist the force of these repeated attacks, and prevent the more rapid decay of the island. Their summits are crowned with a thin but luxuriant soil, from which spring up a few scattered hemlocks and a low underbrush, which nearly obscures the face of the rock, but at the same time furnishes the sea bird a safe retreat beyond the reach of any invader. But at low water a scene of a different character is presented. The visitor, now on the shore beneath, beholds the stupendous objects above him. The towers and precipice seem more lofty than before; and, in addition to the wildness and picturesque beauty of the scene, the naturalist will find before him a field so richly stocked with interesting minerals that he will delight to remain on the spot and gather these objects of science. (See plate II.)

PL. 2

Pendletons Lith.

From nature by C. T. Jackson

PARTRIDGE ISLAND

Detached Masses of trap rocks, South West extremity.

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

Before alluding to these minerals, we would observe that the compact trap forming the highest parts of this island is rarely in masses which may strictly be called columnar, although they have a tendency to that form, and in a few instances, affect the pentagonal shape of basalt. We were unable, however, to discover among them any appearance of articulation in their columnar arrangement. It contains but a small proportion of iron: and consequently the exposed surfaces of the rock are very slightly altered by the oxydation of this metal, which in other places is more sensibly observed.

Of the many interesting minerals to be found at this place, stilbite associated with calcareous spar is the most abundant. This mineral, forming numerous veins in the amygdaloid near the base of the precipice, presents, in the open interstices of the rock, beautiful projecting masses composed of long fasciculated crystals of a flesh red, and sometimes straw yellow color. When crystallized, it is in elongated rectangular four-sided prisms, terminated by tetrahedral pyramids.

The calcareous spar is curiously scattered over the surfaces of stilbite in acute rhomboids, which are often hemitropic, deeply striated upon the faces of cleavage, parallel to their horizontal diagonals, and of uncommon magnitude and beauty. These crystals, usually colorless and transparent, are in a few instances of a rich honey-yellow appearance. In breaking the various masses which are scattered along the shore, it is not unusual to meet with one, which, composed of yellow stilbite externally, contains, within, numerous crystals of calcareous spar lining its walls in rhomboids, which, having their faces deeply indented by the projecting pyramids of the stilbite on which they are implanted, were obviously deposited subsequently to the formation of that mineral.

Chabasie in rhombic crystals, transparent and colorless, also of a beautiful orange yellow color, occurs at this place in the fissures of the amygdaloid. The crystals present brilliant glassy faces, and are very large, frequently measuring an inch across each rhombic plane.

Agates of various kinds, jasper and chalcedony, also botryoidal cacholong, exist in the columnar rock above the accessible base of the precipice: they may be picked up in imperfectly polished fragments among the rolled masses on the shore. A vein of magnetic oxide of iron about a foot wide was also observed entering the superincumbent trap.

But the substance for which this island has long been known by the inhabitants of the country is amethyst; which, occurring plentifully in crystals of fascinating beauty, draws hither the passing traveller, who seldom departs without something ornamental to his parlor shelf, or useful to science.

Pursuing the northern shore of the Basin of Mines, eastwardly, the next place deserving of notice is the vicinity of the Two Islands, about six miles from Partridge Island. The intermediate coast, being composed of rocks of a different character from those which it is our object at present to describe, we shall leave, to notice it more particularly when we treat of that formation.

The Two Islands consist of amygdaloid and columnar greenstone rising on all sides abruptly from the sea, and being accessible at their bases only at low water will not afford the visitor many interesting specimens. On the main land near Swan's Creek, and opposite to these islands, he will be favored with a locality of uncommon interest. At this place also we have a second, and perhaps better developed example of the conversion of shale, red sandstone, and compact trap, first into a coarse breccia, consisting of loosely united masses of these rocks, then into a more compact breccia, consisting of similar masses more closely united, though distinguishable from each other, and finally, by consecutive gradations, into a genuine, well characterized amygdaloid, in which the most critical eye would fail to distinguish separately its component ingredients. We have in our possession specimens from this place, which illustrate perfectly the changes of which we speak, and which present these three rocks tending to the production of amygdaloid. The color of this amygdaloid is obviously governed by the relative quantity of the ingredients composing it; for if the sandstone and red slate predominate, the color is then nearly of a brick red, as the appearance of the rock itself abundantly proves; but when it assumes a greenish or greyish black color, we infer that the slate and sandstone form a comparatively small proportion of the mass.

Having thus adverted to the character of this rock in particular, we shall notice more generally the appearance of the rocks at this place, and then describe the minerals before alluded to as occurring in them. The shore is fronted by a steep bank of about one hundred feet high, from the base of which a slope of dèbris, detached by the frost, inclines down into the sea. One half of this bank consists of trap and the other of red sandstone, intermixed with red shale. Upon it rests a ridge of columnar greenstone. These two rocks come boldly into contact with each other, and the sandstone and shale dipping beneath it, at an angle of forty degrees has the breccia and amygdaloid recumbent on, or more properly, inclining against it; thus presenting, when viewed from the sea, a section of the two rocks crowned with the columnar trap. The amygdaloid is vesicular, and furnishes most of the minerals which we are now to describe. They are chabasie, analcime, heulandite, calcareous spar, and siliceous sinter, all of which occur abundantly, and are often seen richly congregated in the same specimen, or included in the same cavity of the rock.

The chabasie, grouped with its associated minerals, is usually of a wine yellow or flesh red color; but in a few instances it is nearly colorless and transparent. The crystals, which are frequently three fourths of an inch in diameter, exhibit the form of the primary obtuse rhomboid, sometimes so modified, as to assume the lenticular hemitropic form represented in Phillips' Mineralogy, p. 138. At other times, from the almost innumerable faces of composition, they become indescribably complex, or at least would require, for a precise crystallographic description, the consummate skill of a Haüy, a Mohs, or a Brooke. They are slightly striated, of a glistening vitreous lustre, and often hemitropically united. This chabasie agrees in all characters excepting color and complexity of modification with that from the Scottish Islands.

The analcime is in white opaque crystals, exhibiting the passage of the primary cube into the trapesohedron, which it frequently completes, and thus forms crystals which, having twenty four equal and similar trapeziums, entirely obscure the primary planes.

Over the analcime, the heulandite is thickly implanted in small, but extremely brilliant pearly white crystals, which are transparent or translucent, and usually in the primary form, sometimes slightly modified.

The calcareous spar is crystallized in very acute rhomboids, of which scarcely two can be found possessing similar angles. The crystals are also so modified, as to assume the form of the dodecahedron composed of two scalene six sided pyramids, applied base to base. They are greatly elongated, and grouped in delicate stellae, occupying the cavities of the amygdaloid.

Delicate prismatic crystals, but not of sufficient size to determine their form, resembling the Brewsterite from Scotland, occur scattered through the cavities of the trap tuff and associated with perfect and distinct crystals of analcime, constituting interesting specimens.

The last of the minerals which we shall mention as occurring at this locality is silicoius sinter. This mineral is usually embraced in the amygdaloid, forming in its spheroidal cavities, a flaky or lamellar crust, which, enveloping their entire inner surfaces, sometimes depends in stalactitic projections, on which may be observed small crystals of common limpid quartz. Its color, which is usually snowy white, or greyish white, is in a few instances of a beautiful amethystine tint. One or two geodes of this substance were found in breccia, which, on being broken, presented internally a bright coating of amethystine sinter with numerous crystals of wine yellow chabasie implanted in, and beautifully contrasted with it.

The next places to be noticed along the northern shore of the Basin of Mines are the Five Islands, and an eminence known by the title of Tower Hill. Our description of these places will include all that remains to be said relative to the trap rocks of Nova Scotia. These islands form a group situated in a direction south east from the place last described, and about twelve miles distant. They rise abruptly from the sea, and present for the most part lofty fronts of a picturesque character. Three of the group consist entirely of trap, which from the inaccessible nature of their bases, did not admit of particular examination. If the mineralogist however, should select for his excursion a fair day when the turbulancy of the sea has subsided, he will be able to approach their bases, and without leaving the boat, to collect many specimens worthy of his visit. The remaining two are composed of sandstone and red shale, exhibiting in some places, the passage of these rocks into a reddish amygdaloid, vesicular, and zeolitic. In other places, an intermixture of the black shale is observed, which sometimes constitutes a portion of the amygdaloid, and imparts to it a corresponding color, more or less evident as it exists in a greater or less proportion, as an essential ingredient of the rock. The breccia, or trap tuff, which is a constant attendant of the amygdaloid produced by the union of the sandstone, &c. and which seems as an intermediate form necessary to the constitution of the latter, is here observed, as in all other places of similar character, superincumbent on the amygdaloid.

The Island most noted among these is that, which standing in advance of the others, is a conspicuous object to meet the eye of the mariner, in his progress up the Basin. It is composed of amorphous or indistinctly columnar trap, which resting on a softer basis of amygdaloid, presents, from the undermining action of the surges, the curious phenomena of a leaning tower, and, casting a dark, broad shade beneath it, seems as if ready to tumble into the sea from the overhanging weight of its summit.

On the southern front of Tower Hill is a precipice of about one hundred feet high, constituted of red sandstone containing red shale, and having for its summit rock, a low ridge of amorphous trap, resting immediately upon the sandstone, without the intervention of any other rock. It presents vertical veins of quartz, sometimes crystallized, but is void of the zeolites; nor were we able, during our visit at this place, to discover a single crystal belonging to that family of minerals.

This is the last place on the shore of this Basin at which trap rocks are known to occur. Still farther east, the sandstone interstratified with shale, uniformly and uninterruptedly prevails. This spot may therefore be regarded as the extreme eastern limit of the whole trap formation of Nova Scotia, and having for its opposite extremity Briar's Island, which, as may be seen on the map, is not less than one hundred and fifty miles distant, comprising within the intervening space, a field alike extensive for mineralogical and geological research, and replete with numerous objects of natural history.

Having finished our account of the trap rocks forming the North Mountains and their outskirts, which comprise a complete description of that formation, with the more important and curious mineral productions which they include, and having suggested, what appears to us the most obvious theory of their origin, which, derived from remarkable peculiarities of color, structure, and other appearances of contiguous strata, appears to account for those phenomena in a more satisfactory manner than any other, we shall now pass to the neighboring strata of sandstone and shale, forming the moderately elevated and rounded hills of the county of Cumberland, and part of the county of Hants, and part of the districts of Colchester and Pictou.

It becomes necessary to describe the formation before speaking of the South Mountains on account of its intimate connexions with the trap which we have previously alluded to, in describing the capes which project into the Basin of Mines.

The sandstone, constituting so large a portion of the province of Nova Scotia, is of various appearance, differing greatly at different places. In the immediate vicinity of the trap, as at Cape Chignecto, Cape Sharp, and Swan's Creek it is of a dark brick red color, and consists of irregularly rounded grains of quartz, usually very small, rarely exceeding the size of a pepper corn, accompained by minute spangles of mica, and united by an argillaceous cement, containing a large proportion of peroxide of iron. Where in connexion with the trap as before observed, the sandstone passes insensibly into the shale, or rather, the two form a compound in which the eye can distinguish no line of division, so completely are they blended. The shale varies greatly in color, and generally, like the sandstone, becomes red in the presence of the trap rocks, where it assumes a bright tile red color, and when exposed to the action of the waves, it becomes polished on the surface. This rock consists of thin folia of argillaceous slate, sometimes including a little mica, and is generally colored by oxide of iron. Comparatively remote from the trap, the shale assumes a grey, brown, or bluish black color: more rarely it is spotted with green.

Near Diligence River, the shale is almost black, and appears to be colored by carburet of iron. It here includes a large bed of compact limestone, a section of which has been formed by the encroachments of the waters of the Basin of Mines. A little beyond Fox River towards Cape D'Or, the sandstone of a grey color, is seen to alternate with the strata of greyish black shale, both of which are filled with relics of the vegetable kingdom of a former world. They are carbonized remains of various culmiferous plants, which are converted into a compact bituminous lignite.

Portions of ensiform leaves resembling those of the Iris, or blue flag, were here observed, lying between, and included within the strata of sandstone.

The whole northern coast of the Basin of Mines, with the exception of the capes and islands of trap before described, is composed of strata of sandstone and shale, alternating with each other, and presenting to the sea, the edges of their strata, which are finely exhibited by this natural section. They do not attain a great elevation, rarely exceeding one hundred feet, and where exposed to the waves, the strata have suffered much from their violence, and the shale is always worn away, exhibiting the bold ridges of sandstone strata, contrasted with the deep furrows occasioned by its decay. The strata of these rocks are from a foot to four feet in thickness, and are alternately stratified with each other in great regularity: no limit being found to this alternation, we are unable to say which rock is finally subordinate to the other. Near the village of Parsborough, the red shale appears to predominate, and constitutes a bed more than one hundred yards thick, which is beautifully spotted with green, and contains occasionally scattered crystals of yellow iron pyrites. East of this bed the sandstone appears in more powerful strata, and more than compensates for the thickness of the shale just mentioned. It forms a junction with the trap of Swan's Creek, where it includes numerous beds and veins of gypsum, which is of the laminated and fibrous kind. It is occasionally of a delicate flesh color, and the intersecting laminæ are more than a foot in length. The laminated and crystallized gypsum is not sought for exportation so much as the amorphous varieties, which although not so pure, exist in large beds, and are more profitably wrought, while they bear the friction and pressure of transportation without crumbling to pieces, as would inevitably happen to more friable crystalline varieties. At Tower Hill, twelve miles east of Parsborough, the sandstone again meets the trap, which forms but a small part of the precipitous summit, and has no amygdaloid in connexion with it. The united sandstone and shale however, exhibit a most singular appearance, and becoming vesicular, affect a curious imitation of amygdaloid, the place of which it occupies in relation to the trap. These rocks forming the base of the precipice, are of a fine texture, and contain a large proportion of argillaceous matter, colored with oxide of iron.

Passing beneath the trap in its immediate vicinity, it abounds with compressed and flattened spheroidal cavities, which, instead of the zeolites, are, when occupied, filled with rounded masses of gypsum, the mineral which usually occurs in this rock. These facts obviously tend to establish our theory of the origin of trap tuff and amygdaloid, and render probable the explanation of these phenomena: that the quantity of trap present was inadequate to complete the process at this locality.

Beds of gypsum, of practical worth, occur near the head of the Basin of Mines, in the vicinity of the Subenacadie River, where also occurs a large bed of limestone, containing the relics and impressions of marine shells. It is of an ash grey color, and not very compact. In one specimen, a few crystals of galena were observed, scattered through a mass of petrified shells, which resembles the lituites described in Parkinson's Outlines of Oryctology, p. 165, and portrayed in plate vi, fig. 7, of the same work. Much larger and more valuable beds of gypsum occur in the county of Hants, where first explored in the vicinity of Windsor about thirty years ago. It still continues to furnish immense quantities, the greater part of which is sent to the United States. This gypsum is of a bluish color, and is highly valued in the United States as a manure, although in its native country it does not appear to contribute in the least to the fertility of the soil; in fact, the hills entirely composed of gypsum, were not clothed with so luxuriant a crop of vegetation as those where this mineral was altogether wanting in the soil. The trap rocks by their decay furnish a far more productive soil, as exhibited in the township of Cornwallis, justly entitled, the "Garden of Acadia," and the whole extent of the base of the North Mountains.

The gypsum in the vicinity of Windsor, abounds in those conical or inverted funnel shaped cavities, supposed to have originated in the solution of rock salt, (muriate of soda,) which has been imagined once to have occupied those spaces. No salt however, or traces of its existence, were discoverable, and if any exists it is unknown to the inhabitants. In one of these caverns about ten or fifteen years since, the bones of a human being, supposed from the relics of arrows found with them, to have been those of one of the aboriginal inhabitants, were discovered in opening a gypsum quarry. It is presumed that this unfortunate individual, while pursuing his favorite occupation of the chase, was precipitated to the bottom of this frightful dungeon, and being confined by its inclined walls, was unable to reach its summit and regain the light. Thus incarcerated, he perished by hunger. His bones are preserved in the library of King's College, at Windsor, where they were politely shewed us, by the acting Vice President, Rev. Wm. King, who related to us the above story of their origin. The most extensive beds of gypsum in the county of Hants, occur in Newport. On the northeast side of the St. Croix River, which runs through this township, the gypsum forms a precipitous wall rising from the river, and extending along its course. It is extensively wrought, and furnishes more than any other locality in Nova Scotia. The sandstone in which the Newport gypsum occurs, is not of so dark a color as that on the opposite shore of the Basin, in the vicinity of the trap. It is greyish, and some of it almost white, composed principally of quartz, with a small proportion of argillaceous substance for a cement.

On the banks of a small but romantic stream which empties itself into the St. Croix, called Montague River, a remarkably beautiful precipice of siliceous breccia passing into graywacke, presents itself to the traveller. It consists of angular fragments of quartz and felspar, rarely containing a few spangles of mica, united without any apparent cement. The felspar, being of a flesh red color, and forming a principal ingredient in the rock, gives it an appearance at a distance resembling red sandstone. The precipice is about sixty feet high, and rises from a base of the same rock forming the bed of the stream, which has excavated numerous deep holes into the bottom forming beautiful reservoirs of limpid water. The direction of the strata is N.E. and S.W. and the dip 10° to the northwest, forming a declivity down which the water rushes, and falling from the broken strata, produces an agreeable effect. This place, adorned with overshadowing trees, is a favorite resort for the visitors of the Montague House, and has tempted the pencil of a noble lady to portray its beauties.

Gypsum also occurs abundantly in the county of Cumberland, at the head of Chignecto Bay. The most extensive bed is on the banks of the Maran River, where the gypsum is of a bluish color and equal to any in the province.

We shall now advert to the sandstone of Cumberland, and describe the quarries of grindstones and the coal district of this region. The sandstone where it emerges from beneath the trap at Cape D'Or, and where it comes in contact with it at Cape Chignecto, exhibits the red color noticed at other places in the vicinity of this rock, is more compact, and destitute of organic remains. Leaving its Plutonic neighbor further up Cumberland Bay, it assumes a grey color. It alternates with, and passes into a coarse conglomerate. At Apple River and the South Joggin it is quarried for grindstones and as a building material. The sandstone passes into the province of New Brunswick, and forms the extensive grindstone quarries of Meringuin and Grindstone Island; but those places are beyond our limits, and we shall content ourselves with a description of the quarries at the South Joggin and Apple River.

At the former place the best grindstones are obtained and wrought on the shore of Cumberland Bay. They are preferred, when obtained at a considerable depth from the superficial strata, and are always taken at low water as deep as possible from the surface. Two or three layers are first removed which make inferior grindstones, and then the best ones are procured. In cutting the stones, the workmen frequently meet with hard rounded nodules which they call "bulls eyes," and which always condemn the stones as useless. They differ from the surrounding matrix only in being more compact and having less of the argillaceous basis, and breaking with a conchoidal fracture. The bulls eyes differ in size from one to ten inches in diameter, and sometimes include a smaller spheroid as a nucleus within the larger.

Near the mouth of Apple River, grindstones are also quarried in a similar manner to those of the South Joggin; they are not of so good a quality, but in other respects they are like those already described. The rock of which the grindstones are made consists of irregularly rounded grains of quartz, which are transparent and colorless or slightly tinged red, green or blue, with a few spangles of mica and grains of felspar interspersed through the mass. The grains are usually minute, and not often exceeding the size of a mustard seed. They are united by an argillaceous cement, which exists in a small proportion to the whole. This rock contains numerous remains of culmiferous plants, which lie between the strata and are much compressed. They do not injure the grindstones unless many occur in the mass, which seldom happens, as they are mostly scattered diffusely through the strata. The fossils which occur in this sandstone, stamp it as a secondary rock, although it is evidently older than the trap rocks recumbent on it along the margin of the Basin of Mines.

A few miles south west from the grindstone quarries at the South Joggin, a bed of bituminous coal exists in the sandstone, accompanied by shale. The bed is about five or six feet thick, and has been wrought to a small extent, but is now abandoned, and the shaft is filled with earth and rubbish. The coal contains an abundance of pyrites, which injures its quality as an article of fuel. In the vicinity of this bed occur several smaller beds, one of which is covered by a stratum of bluish compact limestone, in the upper surface of which Dr. Lincoln observed fragments of shells resembling those of the common muscle. (*Mytilus edulis?*) Many of the vegetable fossils so common in the rocks of the coal series in other countries are found in great abundance here, imbedded in the sandstone, which dips at an angle of thirty degrees from the horizon, and includes the coal. Specimens of the phytolithus verrucosus were found by Dr. Lincoln, which exactly resemble those represented in the drawings accompanying Mr. Steinhauer's article on these fossils in the American Philosophical Transactions, New Series, Vol. I. Pl. IV. fig. 1. 2. and 4. Very good specimens of the fossil represented in Parkinson's Organic Remains, Vol. I. Pl. IX. fig. 1. were also found. Substitutes of reeds and of plants resembling bamboos and rushes are likewise abundant. Some of the reeds are three or four inches in diameter and as many feet in length. They are invariably found traversing one or more of the strata at right angles with its layers. Some, especially the larger, are cylindrical; others are flattened and are generally coated externally with a layer of coal; some are smooth, others striated longitudinally as represented in Parkinson's Organic Remains, Pl. III. fig. 3. Near the principal coal bed, Dr. Lincoln saw one segment of a trunk two feet long and twenty five inches in diameter, and another about one foot long and eighteen or twenty inches in diameter. The external appearance of this petrifaction had led the grindstone cutters to believe it to have been a hemlock tree (Pinus Canadensis.) They say that a few years ago a large part of the trunk was standing erect in the cliff, with some of its branches attached to it.

Lignites are very abundant. Some specimens appear to have been trunks of trees or succulent plants of an enormous size, and they are found, not traversing the strata of the rocks like the stony casts of the reeds, but lying between them.

The Isthmus connecting Nova Scotia with New Brunswick, situated between Cumberland Basin and Bay Verte, is but twelve or fourteen miles wide from one shore to the other, and being composed of a friable decomposed sandstone, opposes a feeble resistance to the rushing waves of Cumberland Bay, where the tides rise to the height of sixty feet; while on the shores of Bay Verte they scarcely attain the elevation of eight or ten feet. One would suppose such frail barriers would give way before the pressure and violence of the conflicting tides. It is, however, a remarkable fact, that the same waves which cause so much devastation along the rock-bound coast of the Bay of Fundy, undermining and tumbling in confusion the lofty trap rocks, roll harmless against these shores, protected by the bold promontories of Cape Chignecto and Meringuin, depositing their spoils taken from the opposing rocks, quietly on the shores of Cumberland Basin, and thus fortifying the isthmus in its weakest point. The inhabitants assist the process, securing by dykes the soil deposited on their lands, and profitably use the bounties heaped at their doors by the tumultuous sea.

From the shores of Chignecto Bay the sandstone and slate, forming the county of Cumberland, extend to the waters of the Gulf of St. Lawrence on the north, and, stretching eastwardly towards the county of Sidney, constitute a part of the districts of Colchester and Pictou. The interior of Cumberland county was not examined by ourselves, but we were credibly informed by intelligent persons residing there, of the extent of the sandstone district as represented on the geological map accompanying this essay.

Salt springs have been found in various places near the shores of the Gulf of St. Lawrence. One of the most important exists near the river Philip. The brine of this spring contains a much larger proportion of salt than the water of the ocean, and it has been economically obtained by evaporation of the water. In the year 1811 large quantities were manufactured at this spring. A spring also occurs at Pictou, which was advantageously worked for salt on an extensive scale for several years, but is now abandoned, from what cause we are not informed. No rock salt has ever been found in the vicinity of these springs, nor has the rock any perceptible salt taste. We must therefore refer the origin and the occurrence of these salt springs to such unexplained phenomena as are assigned to those in the western part of the state of New-York, so ably discussed by Prof. Eaton in his "Geological and Agricultural Survey of the District adjoining the Erie Canal." See Part I. p. 109. sqq. The existence of salt springs in this formation indicates it to be identical with the saliferous rock of Phillips and Conybeare, and allies it to the extensive deposit described by Prof. Eaton as existing in the western part of the state of New-York, in his excellent survey of the Erie Canal, and in the Amer. Journ. of Science, vol. xiv. No. 1, p. 148, as existing on the banks of the Connecticut, and as supporting the Palisades on the Hudson river.

Pursuing this formation eastwardly in the direction of its strata, we meet with occasional beds of coal, not of any practical worth, and offering no remarkable geological peculiarities. On the north bank of the West river, where the Kempt bridge crosses this stream, a bed of bituminous coal with lignites, about four or five inches wide, occurs in the cliff of sandstone, a section of which is formed by the bed of the river. At this place, which we mention on account of its vicinity to the road from Truro to Pictou, rendering it accessible to travellers, occur many of the relics of culmiferous plants before noticed at Cumberland mine.

Carriboo river, in the township of New Philadelphia, seven miles north of the flourishing town of Pictou, presents a field of great interest both to the mineralogist and the miner. On the banks of this stream, two miles from where it empties into the Gulf of St. Lawrence, occurs a bed of copper ore, included between the strata of sandstone passing into coarse conglomerate. It is associated with lignites of enormous size, which generally lie over the copper ore. The conglomerate consists of smooth rounded masses of quartz of various colors, siliceous slate, clay slate, and felspar, varying in size from that of a filbert to three or four inches in diameter; they are united by an argillaceous cement. The sandstone differs only with regard to the size of the component ingredients, which diminish until they are scarcely distinguishable by the naked eye. These rocks rise from the river to the height of fifteen or twenty feet above its level, and form banks precipitous to the stream. The direction of the strata is nearly east and west, and the dip is about ten degrees to the north. The lignites are black, and some resemble common charcoal so much as to be readily mistaken for that substance. Some are fibrous, and exhibit evident traces of the organized structure of plants; others have lost every trace of organization, are compact without any fibrous structure, break with a conchoidal fracture, and have a glossy black color. They take a good polish, and resemble the jet with which this substance is evidently identical. It occurs forming a thin layer over masses of the copper ore which sometimes forms casts of culmiferous plants resembling the stalks of Indian corn (zea mays.)

The lignite sometimes contains minute flattened crystals of red oxide of copper, which are translucent, and possess a crimson red color.

Green carbonate of copper occurs investing some of the lignites; and, filling interstices in the sandstone, it assumes a botryoidal appearance. It also occurs in delicate fibres investing the masses of *vitreous copper ore* now to be described.

This valuable ore occurs in beds from two to four inches thick, which, covered with lignites, alternate with each other, the lowest bed being the thickest and most compact. It is of an iron black color, with a slight tinge of lead grey. It possesses a metallic lustre, and breaks with a conchoidal fracture. Some specimens are of a crystalline or granular structure, breaking so as to exhibit brilliant metalloidal surfaces; others are very compact, and break with a smooth surface. The specific gravity of the most compact variety is 5.7—but the granular varieties, more open in their texture, seldom exceed 4.8 or 5. It is sectile, and readily impressed by a smooth blunt steel instrument; it therefore possesses a low degree of malleability, being extended under pressure without breaking. It receives a fine polish, and is highly splendent, resembling in lustre and color the most highly polished steel. It retains this lustre unaltered by the action of the atmosphere. It is mixed occasionally with yellowish and a lighter grey pyrites, which is much harder, and not sectile. It contains a smaller proportion of copper and more iron; but no specimen of this ore gives any traces of arsenic or antimony when examined before the blowpipe, or when dissolved in nitro-muriatic acid, and largely diluted with water.

Nor does a solution in nitric acid give any precipitate when muriate of soda is added; and sulphuric acid throws down no precipitate; hence it does not contain any silver or lead. The nitric solution, tested by aqua ammoniæ, became of a fine blue color, and, treated to excess of saturation, gave a brown precipitate of oxide of iron.

To determine the composition of the vitreous copper, similar trials were made, which discovered nothing but copper, sulphur, and iron. This ore was called by the miners from Cornwall, who were exploring the mine, grey copper, (fahlerz of the Germans.) But according to an accurate analysis which we have made of this ore, it is to be considered as the vitreous copper, (kupferglanzerz,) which is more valuable than the grey copper ore. We have taken for our model the analysis of the vitreous copper ore from Siberia, detailed in the celebrated essays of Klaproth. As our results differ somewhat from those of this excellent analyst, and no source of fallacy can be discovered on repetition of the process, we shall give an account of the method pursued, although it possesses no claim to originality, but was purposely conducted after the manner of this chemist. We are the more disposed to do this, as many of our readers cannot have access to the work of Klaproth, which has become scarce, and may still wish to see the *modus operandi* exemplified.

ANALYSIS.

A specimen of the copper ore was selected, having the specific gravity 5.7. It was sectile, possessing on the cut surface a brilliant metallic lustre, resembling polished steel, but more of a lead grey appearance. It was carefully freed from the surrounding matrix and envelope of lignite, and reduced to powder.

A. Two hundred grains of this powder were introduced into a matrass, and pure muriatic acid affused upon it, which dissolved nothing, even when heated to boiling; shewing that the metals do not exist in the state of oxides, but in a metallic state.

B. To the contents of the matrass while boiling, hot concentrated nitric acid was added by drops, which at each addition occasioned a violent effervescence, with the extrication of red fumes. The acid was added until it ceased to produce action. A flocculent greyish white precipitate had formed on the surface of the fluid, which was the sulphur extricated from the ore. When cool, the contents of the matrass being diluted with pure water, and carefully washed from its surface, were thrown on a filter of known weight. The precipitate collected on its surface, washed with dilute nitric acid, and afterwards with water, being dried, was found to weigh thirty-eight grains. This was ignited in a crucible of platinum over an alcohol lamp, and burned away, leaving two grains of a dark grey powder, which was a portion of the ore that had escaped decomposition. This was treated with nitro-muriatic acid, and being dissolved by it, was added to the filtered solution. The sulphur then in two hundred grains amounts to thirty-six grains, or eighteen per cent.

C. The liquid which had passed the filter was of a bluish green color, and transparent. It was divided into two equal quantities. In one portion a polished cylinder of iron was immersed, and in forty-eight hours the copper had precipitated upon it in a dendritic form. That it had entirely separated the copper was known by the solution ceasing to give a tarnish of copper to a polished steel instrument. The copper removed from the cylinder of iron, washed and dried rapidly to prevent oxidation, was found to weigh 79.5 grains.

D. The other half of the solution was treated with aqua ammoniæ to excess of saturation, when a muddy brown precipitate took place, which, when collected on a double filter of known weight, washed, dried, and ignited with a little wax in a platinum crucible, was reduced to the protoxide of iron attractable by the magnet, and weighed 3.4 grains, indicating 2.5 grains of metallic iron.

E. To determine whether the solution was equally divided, and to prove the correctness of the process C. the ammoniated solution was saturated and acidulated with sulphuric acid, and a plate of polished iron immersed in it. The copper precipitated in a brilliant metallic coating, and when separated, washed and dried, weighed with the loss of a trifling fraction, like the result of the former process 79.5 grains.

This ore contains, then, in a hundred parts,

Copper, - - - - -	(C)	79.5
Sulphur, - - - - - -	(B)	18.0
Iron, - - - - -	(D)	2.5
		100.0

The sandstone continuing its eastward course through the district of Pictou, approximates to the slate of the South Mountain range, which it meets in the township of Egerton, near the sources of Middle and East Rivers. In the village of New Glasgow, there occurs an important bed of bituminous coal near the East River. It is included between the strata of sandstone and is overlaid by a decayed, blackish shale. The coal is of a jet black color, has a glossy appearance, and is highly charged with bitumen. It burns with a bright flame, and smokes much when first kindled. It appears to melt and cake like the Newcastle coal, and when completely on fire, after the bituminous matter is dissipated, it burns like coke. These characters show that it is a valuable coal, and of good quality, fitted for all the purposes of that brought to this country from England. All that has yet been raised has a fault which greatly injures it for the market. It is very soft and friable, insomuch that it is broken into "small coal," or even ground into dust by friction in transporting it to any considerable distance. There have been five or six shafts sunk in different parts of this bed, mostly under its former lessee, Mr. Carr, who resides at this place. One of these is seventy or eighty feet deep, sinking perpendicularly like a well through the surface into the bed of coal. This has been effected by "gins" and buckets worked by horse power. We believe it never afforded much profit to the persons engaged in working it, for the mine had been abandoned for a long time when we visited it, and the former machinery was almost destroyed by decay. Preparations were then making to explore this mine on a generous scale. A company had been organized in London to work the coal, and two very intelligent and practical gentlemen, Messrs. Smith and Brown, had been sent to superintend the operations, with more than a hundred European miners to assist in the work. They were building two steam engines to pump the water from the shafts, and to raise the coal. With such adequate means, strong hopes are entertained of obtaining coal of a more compact nature suited for exportation. We are unable to form any opinion respecting the foundation of these sanguine expectations, as the state of the shafts, being partly filled with water, precluded the necessary examination of the bed and associated rocks. We were informed that Mr. Carr had cut through the whole thickness of the bed with his principal shaft, and had found the black shale beneath, which he did not perforate. We saw masses of this rock lying in the vicinity of the shaft, which we were told were obtained in his last diggings. If another stratum of coal lies beneath this layer of shale, it is doubtless more compact, from the pressure of the overlying rocks during its formation. We must remain undecided as to the fact until the mighty strokes of the steam engine break away the obstacles to its examination, when treasures may be brought to light rewarding the labors of the miner, and contributing new facts to the imperfect science of geology.

We observed several fine specimens of remarkably perfect stony casts of culmiferous plants, in possession of Mr. Blanchard of Truro, which he informed us were obtained at the New Glasgow Mines in raising the coal. They resemble those found at Cumberland, and mark this deposit as coeval with that formation.

About twelve miles northeast from the coal mines of New Glasgow, and eighteen miles from the town of Pictou, the sandstone, with its accompanying shale, approximates to the transition clay slate of the South Mountain range. The immediate junction of these rocks was not discovered on account of the deep, unbroken soil which overlaid and concealed from view their respective strata. It appears evident that the strata unite near this place, from the fact that their lines of bearing here intersect each other at an acute angle; the bearing of the clay slate being north sixty degrees east, while that of the sandstone is directly east. The clay slate dipping at an angle of fifty or sixty degrees to the northwest, while the sandstone dips at angles of only ten or fifteen degrees to the north, clearly indicates the former rock to be of greater antiquity than the latter, and seems a well founded character for considering the clay slate of the South Mountains as belonging to the transition class of rocks, which we shall confirm when treating of that formation. The sandstone was before proved to be secondary from the fossils it contained. It evidently lies over the clay slate, and we regret exceedingly that we were unable to discover a single spot from which the soil and gravel had been removed, so as to exhibit the connexion of the two rocks. Future explorers by traversing the forests, may perhaps find an outcropping somewhere along the line of their union, which will repay the labor of research, by illustrating their relations and comparative age.

On the estate of Alexander Grant, we observed, in the bed of a brook proceeding from the forest, a section of red sandstone and shale, including a bed of red and brown hematitic iron ore twenty feet wide, and of unknown thickness, it not having as yet been explored for practical purposes. This hematite exhibits all the varieties of imitative form usually assumed by this ore, and resembles precisely those beautiful specimens brought from the Salisbury mines in Connecticut which so frequently adorn mineralogical cabinets. It occurs botryoidal, and stalactitical, and sometimes possesses a brilliant, tubercular surface, consisting of small hemispherical elevations.

Grey oxide of manganese is associated with this ore, and forms a considerable proportion of the bed. It is sometimes crystallized in the cavities of the hematite, but more frequently is disseminated in radiating acicular fibres or distinct concretions through the mass. Its color is between lead and steel grey, and it possesses a high metallic brilliancy, which is not tarnished by exposure to air and moisture. The geodes in the hematite are frequently occupied by crystals of arragonite, in six-sided prisms, and also sulphate of barytes in compressed or tabular crystals, usually of a pure white color, and but very loosely attached to the matrix, or they are sometimes completely isolated. Several masses of a foliated structure, composed entirely of this substance, were also found in the soil near this brook. Whether the manganese, intermixed with this ore, will prove injurious to the iron in the operation of smelting it, or not, is, we think, a question of importance to those interested in the establishment erecting at New Glasgow for working it extensively, or as is contemplated with the coke or carbonaceous base formed by the destructive distillation of bituminous coal, which is now exclusively employed in England, in the reduction of iron ores. It is certain that this substance, whether reduced to the metallic state or not, so as to combine chemically with the iron, must nevertheless have an injurious effect in the smelting furnace; for in consequence of its existing in the state of per oxide, a large portion of heat and carbon is taken up in the form of carbonic acid, or oxide, by uniting with the oxigen; and thus depriving the iron of more or less of its carbon, renders it of inferior quality.

A bed of buff colored limestone occurs in the sandstone near the hematite locality, and will prove a valuable fluxing material to the ore, which may be worked in this section of the province.

Four miles southeast of this place a very important and extensive bed of iron ore exists, in the clay slate of the South Mountains, which we shall describe after noticing generally the whole transition clay slate formation of Nova Scotia, commencing at the eastern extremity of the district of Pictou, and extending west south west, through the province to St. Mary's Bay, where it approximates to the secondary trap rocks, and is connected with them by Digby Isthmus, which is composed of sandstone, as observed in the first part of this article. For this connexion, see the map.* This rock presents a larger extent of surface, than any other in the province, forming more than one third of the whole face of the country. It presents every where a uniform geological character, and containing fossil organic remains, belonging to the marine world alone, (no vestiges of the vegetable kingdom being discoverable,) it must obviously, according to the great geological division of rocks, be regarded as transition, and as having existed long before the neighboring plutonic rocks had emerged from the central regions of the earth. That this rock is older than the trap rocks we have additional, and almost decisive evidence, derived from another source, which we shall state by and by, when our observations are directed more particularly to the iron ore bed which we have no hesitation in saying is co-extensive with the whole formation.

The direction of the strata composing this formation is uniformly north, 60° east, dipping at an angle of 50° or 60°, from the horizon. The color of this rock on fracture, is black, greyish or bluish black. Its structure is slaty or foliated, frequently separating by a gentle blow into broad sheets which are sufficiently smooth and compact to be employed for writing slate. This is the case at Rawdon, where it is obtained for this purpose, and extensively quarried for roofing slate. In other places being less distinctly foliated, its tendency is to break into huge rhomboidal fragments, as it has natural seams both in the direction of, and at right angles with its stratification. This renders it a valuable building material as it forms convenient shapes for rearing walls

* In Vol. XIV.

of houses, for which purpose it is employed in many places, as at Clement's, in Annapolis county.

The soil resulting from, and lying over this formation is naturally and very perceptibly inferior, to that produced by the disintegration of the trap rocks of the North Mountains, and the neighboring sandstone, its vegetation being less luxuriant, and requiring for its culture greater labor from the husbandman. This is a fact which a traveller in passing through the country, cannot fail to observe. The soil has been much improved of late years, and the present state of agriculture in Nova Scotia, is much indebted to Mr. John Young, the author of a series of interesting and practical letters published in Halifax under the signature of "Agricola," and which resulted in the formation of several agricultural societies.

The continuity of the strata of this rock is interrupted in two places by dykes of green stone porphyry, which, entering the rock nearly at right angles with its stratification, completely cut off, or intercept the bed of iron ore which is continuous and parallel with the strata. We shall notice these dykes more particularly in another place, as also the patch of granite represented on the map in Annapolis county, which is undoubtedly subordinate to the clay slate, and all the other rocks in Nova Scotia.

The bed of iron ore before alluded to is apparently sixteen feet wide, though from its not having been explored at the time we visited it, so as to present the contiguous strata of slate, we cannot state the exact width with certainty. Its direction, like that of the strata in which it is included, is north 60° east, and is traceable for a considerable distance into the forest, until it is entirely obscured by the soil and underbrush.—The ore on the surface from which considerable quantities may be detached, is usually of a compact structure, sometimes inclining to slaty. Its external color is brown and reddish brown, but its streak and powder are between brick and blood red; consequently, it is in the state of the red or peroxide of iron. It is destitute of magnetism and metallic brilliancy. Its specific gravity is on an average 4.00—hence, according to Rinman's method of calculation, it contains fifty per cent of pure iron, a very near approximation to the truth, as proved on assaying the ore in the crucible, and making an allowance for the carbon combining with it in the process. Some specimens of this ore in which the fossil remains are uncommonly prevalent, contain lime in the state of carbonate, readily effervescing with acids. It contains besides, a portion of alumina, and silex, which in smelting perform the important function of a flux.

To be continued.

Obituary.*—Died, at his residence at Tottenham, (five miles from London,) on the 4th of April last, William Phillips, F.R.S. &c. co-author of the Geology of England and Wales, author of a treatise on mineralogy, and of various other useful publications. The death of this philosopher and philanthropist, leaves no inconsiderable blank among the worthies of his age and country. But little past the middle period of life, his friends were encouraged to expect from his genius and industry more extended labors in those regions of science which he cultivated with so much success. As a husband, parent, and companion, the language of eulogy would scarcely admit of exaggeration. Buoyant in spirits, yet acute in his feelings, generous and indulgent in his sympathies, though quick in the perception of error, with a mind stored with various knowledge, and a heart formed for friendship, his conversation and correspondence possessed attractions which will long be prized by those who enjoyed them. He was a member of the society of Friends, highly respected, and though educated by pious parents, his eventual belief was the result of investigation, and of a conviction of the truth of the Gospel Dispensation and of its invaluable benefit to man. By this his principles were enlightened and his conduct guided, though at all times free from the forwardness of religious pretension.

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* It so happened, that the miscellanies of the present number were printed, before the preceding articles were finished; and we therefore insert in this place, the painful notice of Mr. Phillips' death, just received from Professor Griscom.—Ed. *Sept.* 10, 1828.

INTELLIGENCE AND MISCELLANIES.

I. Foreign.*

1. *A Summary of an "Account of an Orang Outang, of remarkable height, from the island of Sumatra. By Clarke Abèl, M. D."* Communicated in a letter to Dr. Brewster.

In his letter to Dr. Brewster, the author states; "The notice is taken from a paper which I had lately the honor of reading to the Asiatic Society."

I have little to remark in addition to what the notice contains, except that the youth of the animal, was equally proved by the state of its teeth, and by the apophysis of the bones of its hands and feet being incompletely ossified. The general conclusions to which I have come, from a considertion of all the circumstances I have collected respecting this animal, is, that it is identical with the Orang Outang, described by Wurmb in the *Batavian Transactions;* that Cuvier is right in considering Wurmb's animal as the adult of the young eastern Orangs seen in Europe; but he is mistaken in supposing that it is also the adult of the African species.

The height of the animal under consideration, as described by authors, varies from five to seven feet; it has so near an approximation to the human form, as to have been thought by some superficial naturalists, a part of the human species. The last joint of its fingers, the palms of its hands, the soles of its feet, and its face, like the same parts of the human form, are free from hair. The depression of its nose, however, the lowness of its forehead, the absence of a prominence of the chin, and the general proportion and orbicularity of the face, strongly distinguish it from the symmetry of the human countenance. The animal is represented as walking erect, as possessing a degree of sagacity approaching to human intelligence, and as exhibiting in common with man, feelings of aversion and attachment. These traits so far as

* We now give the sequel of the "extracts and abstracts" mentioned in the last number, page 369, which were prepared some time since, but which appear to be still interesting and valuable. Prof. Griscom's recent extracts follow as usual.—Editor.

they are not common to the brute creation, are deemed the results of tuition.

The Orang Outang which is the subject of the present article, was discovered on the north coast of Sumatra, by a party from the Mary Anne Sophia, Capt. Cornfoot, landed there for the purpose of watering. When the animal made its appearance, it seemed as if it had come from some distance; and to all appearance, it had been walking through a swamp, its legs, up to the knees, being muddy. Its gait was slovenly, and as it went, it waddled from side to side. Captain Cornfoot dwells much upon the human like expression of his countenance, and especially on the beautiful arrangement of his beard. He also obliged me with some account of his capture, as reported to him by his officers, and feelingly described the piteous action of the animal on being wounded, and its apparent tenacity of life. It seems that, on the spot where this animal was killed, were five or six trees, which occasioned his hunters great trouble in procuring their prey; for in consequence of the extreme agility, and power of the animal in springing from branch to branch, and bounding from one tree to another, his pursuers could not fix their aim, until they had cut down all the trees but one. When thus limited in his range, the Orang Outang was shot, but did not die till he had received five balls and the thrust of a spear. One of the first balls probably penetrated his lungs, as he immediately after the infliction of the wound, slung himself by his feet from a branch, with his head downwards, and allowed the blood to flow from his mouth. On receiving a wound, he always put his hand upon the wounded part, and distressed his pursuers by the human like agony of his expression. After the fifth shot, it climbed a tree and reclined against its boughs to all appearance in great pain, and vomited a considerable quantity of blood. When on the ground, after being exhausted by his many wounds, he lay as if dead, with his head resting on his folded arms. It was at this moment, that an officer attempted to give the coup de grace, by pushing a spear through his body, but he immediately jumped on his feet, wrested the weapon from his antagonist, and shivered it in pieces. This was his second, and last great exertion; yet he lived some time afterwards, and drank, it is stated, large quantities of water.

The height of the animal, as stated in general terms, was upwards of seven feet, from measurements of the prepared animal, by Dr. Clarke, seven feet six and an half inches were obtained as his approximate height.

The measure from the extremity of one arm to that of the other, eight feet two inches.

Description of the remains of the animal.

The face of this animal, with the exception of the beard, is nearly bare, a few straggling, short, downy hairs, being alone scattered over it. It is of a dark lead color, excepting the margin of the lips, which are lighter. The eyes small, in relation to those of man, and are about an inch apart. The eye-lids are well fringed with lashes. The ears one inch and an half in length, and barely an inch in breadth, are close to the head, and resemble those of man, with the exception of wanting the lower lobe. The nose is scarcely raised above the level of the face, and is chiefly distinguished by two nostrils, three quarters of an inch in breadth, placed obliquely side by side. The muzzle projects in a mammillary form. The opening of the mouth is very large, when closed the lips appear narrow, but are in reality half an inch in thickness. The hair of the head is of a reddish brown, grows from behind forwards, and is five inches in length. The beard is handsome, and appears to have been curly in the animal's life time. Its color is lighter than that of the head, approaching to a light chestnut, it is about three inches long, springing very gracefully from the upper lip, near the angles of the mouth, in the form of mustachios, whence descending, it mixes with that of the chin, the whole having a very wary aspect. The face of the animal is very much wrinkled.

The palms of the hands are very long, are quite naked from the wrists, and are of the color of the face. Their backs are covered with hair to the last joint of the fingers, and this inclines backwards towards the wrists, and then turns directly upwards. All the fingers have nails, which are strong, convex, and of a black color. The thumb reaches to the first joint of the fore-finger. The soles of the feet are bare, and of the same color as the hands; they are covered on the back with long brown hair to the last joint of the toes. The great toe is set on nearly at right angles to the foot, and is relatively very short. The original color, however, of the hands, arms and feet is somewhat uncertain, in consequence of the effect of the spirit in which they have been preserved.

Description of the skin of the animal.

The skin itself is of a dark, leaden color. The hair is of a brownish red, but when observed at some distance, has a dull, and, in some places, an almost black appearance, but in a strong light, it is of a light red. It is in all parts very long; on the fore arm it is directed upwards. On the upper arm its general direction is downwards, but, from its length, it hangs shaggy below the arm. From the shoulders, it hangs in long and large massy tufts, which, in continuation with the long hair on the back, seems to form a continuous mass to the very centre of the body. About the flanks the hair is equally long, and, in the living animal, must have descended below the thighs and nates. On the limits however of the lateral termination of skin, which must have covered the chest and belly, it is scanty and gives the impression that these parts must have been comparatively bare. Round the upper part of the back, it is also much thinner than elsewhere, and small tufts at the junction of the skin with the neck, are curled abruptly upwards, corresponding with the direction of the hair at the back of the head.

2. *Observations on the temperature of Man, and other Animals.*—By John Davy, M. D. F. R. S.

The conclusions to which Dr. Davy arrives after his numerous experiments are, "That the temperature of man increases after passing from a cold, or even temperate climate into one that is warm,—that the temperature of the inhabitants of warm climates is permanently higher than the temperature of those of mild,—and that the temperature of different races of mankind, *cæteris paribus*, is very much, influenced by the climate; these are conclusions which the preceding observations on man may seem to warrant.

The first conclusion, I am aware is not novel; but I do not know that it was ever drawn before, excepting from very scanty data.

The second conclusion, though conformable with the first, is I believe, new; indeed it is contrary to a received opinion that the temperature of man in warm climates, is actually lower than in cold. The opinion alluded to, I conceive, arose partly from hypothetical views of the subject; and if I recollect rightly, it has been supported only by two or three observations recorded by Dr. Chalmers in his history of South Carolina, which were made at a time when thermometrical experiments were not very common, and when the standard temperature of man, was rated much too low. Farther refutation of this opinion is perhaps unnecessary. The experiments I have made, with all the care in my power, are so numerous, and their results are so consistent, that if I do not deceive myself, they put the question beyond the shadow of doubt, and fix as a fact, that if the standard temperature of man, in a temperate climate, be about 98°, (which I believe is the nearest approximation to the truth,) in a hot climate, it will be higher, varying with atmospheric variation from $98\frac{1}{2}$° to 101.

The third conclusion I believe to be perfectly accurate; I say *believe*, because it is difficult, if not impossible, to collect more than presumptive evidence on the subject. However, may not the evidence be considered sufficiently satisfactory, since the variation of the temperature of the different races I tried did not exceed, in degree what may be witnessed amongst different individuals of a ship's company, all of one nation, or even amongst different members of the same family? The similarity of temperature in different races of men is the more remarkable, since between several of them, whose temperatures agreed, there was nothing in common but the air they breathed, some feeding on animal food almost entirely, as the Vaida,—others chiefly on vegetable diet, as the priests of Buddho,—and others, as Europeans and Africans, on neither exclusively, but on a mixture of both.

Farther, that the temperature of birds, of all animals is the highest, that of the mammalia next, that of the amphibia, fishes and certain insects, next in degree,—and lowest of all, that of the mollusca, crustacea, and worms,—are conclusions, with few exceptions, that may be deduced from the preceding experiments on temperature of animals in general. Moreover since in general, as far as experiment and observation have yet gone, there appears to be a decided connexion between the quantity of oxygen consumed by an animal and the animals heat, is there not good reason to consider the two in relation of cause and effect. If animal heat be owing to nervous energy, or any way connected with the nervous system, why, it may be asked, are birds so much hotter than the mammalia? why is the temperature of most quadrupeds higher than that of man? Or if it be owing to digestion, and secretion, and animal action, why is the temperature of the amphibia and of fishes so low where powers in respect to these functions are so considerable?

Or if it be connected with muscular energy, why are the animals whose muscular powers are most remarkable, the animals belonging to all the lower classes, equally remarkable for the lowness of their temperature?

Or lastly, if animal heat depend at all on peculiarities of structure and organization, why, it may be asked, is not the temperature of the amphibia, elevated like that of birds—the structure of the respiratory, and digestive, and secreting organs of one class, being so much like those of the other? —*Ed. Phil. Jour.*

3. *East Coast of West Greenland, formerly inhabited by Europeans.*—Early history informs us that a part of the east coast of West Greenland, was colonized by Norwegians from Iceland. The colony appears to have been considerable, and to have extended northward to Lat. 65° or 66.° Some authors, (and particularly a writer in the Edinburgh Review,) maintain, that no such colony ever existed; on the contrary, that the Norwegians landed and colonized the west, not east coast of old Greenland. The late observations of Scoresby, and the details given by Gieseckè, in a memoir published in the Transactions of the Royal Irish Academy, demonstrate the futility of the opinion, just mentioned. Gieseckè, who spent eight years in Greenland, tells us he met with upwards of fifty Norwegian houses, in the fiords or firths of South and East Greenland, fragments of church bells, and sculls of the Caucasian or European race of men. In the language of the Greenlanders, he detected many Scandinavian or Icelandic words, used in domestic life, a proof that there existed a friendly intercourse between both nations. Many plants foreign to this part of the Arctic Flora were met with, probably imported by the Norwegian settlers, such as the sorbus aucuparia. In reference to the destruction of the colonists, our author remarks; "All the ruins of Norwegian houses were surrounded by immense mas-

ses of rocks, probably precipitated from the summits of the adjacent mountains, and heaped together in the most fantastic groups. Places of desolation of this kind, are frequently met with among the mountains, connected with the sea by water-falls, which are precipitated with tremendous velocity from the rocks covered with glaciers. I have no doubt that such changes, caused by the bursting of glaciers, and the subsequent inundations, have produced these scenes of desolation; and that perhaps the Norwegian settlers perished, and were buried in the ruins caused by such destroying powers."—*Ed. Phil. Jour.*

4. *On the Preservation of Zoological Specimens from the depredations of Insects; by* Thomas S. Trail, M. D. F. R. S. E., &c. Communicated by the Author.

The author remarking upon those compositions which contain as ingredients, arsenic and corrosive sublimate, says "they are well known to be very effectual, when properly applied; but unless used with caution, they are apt to injure the natural pliancy of the skins, and they can scarcely be effectually employed to protect collections of insects. I have known these substances, even in the hands of the most expert, produce such *tenderness* of the skins impregnated with them, as to form a considerable obstacle to setting up the specimens." After speaking of tallow and camphor, (the first of which he has not tried, the other has known to fail) he proceeds; "Every substance which I have yet tried seems to be inferior in efficacy and ease of application to the following,"—the method of Mr. William Gibson, preparer of objects of Natural History, residing in Liverpool, which I shall transcribe from his own communication to me.

"I have found" says he, "that nothing destroys insects so effectually as *rectified oil of turpentine*, and my method of using it is as follows: I put the turpentine into a bladder, the mouth of which is firmly tied with a waxed string and nothing more is necessary than to place the bladder, thus prepared, in the box with the birds, or tie it to the pedestal on which the birds are perched in a case. If there be any maggots on the birds, I have invariably found, that they will soon be dislodged from the feathers, fall to the bottom of the case, and die in the course of a few days. It is also stated that the turpentine is equally hostile and fatal to the common house-fly, the large blue-bottle-fly, moths, and cockroaches; that a single drop applied to the corselet is more effectual in speedily killing perfect insects, than the more common method of dipping the transfixing pin in aquafortis. For destroying the minute white *acari*, that infest the hairs of specimens it proves speedily effectual." As far as I can judge, this method promises, from its cheapness, and easy application to be very useful, not only to collections of natural history exposed to public view, but will materially abridge the labor, and save the precious time of the scientific traveller in preserving his collections. It will also, I doubt not, prove an acceptable boon to furriers, and other dealers in peltry. And the anatomist would probably also convert it to his use with much advantage.—*Ed. Phil. Jour.*

5. *Falling Stars.*—Dr. Brandes of Breslau, and several other meteorologists, have for sometime past been actively employed in making corresponding observations on falling stars. Although these remarkable meteors, apparently situated beyond the atmosphere of the earth, at first sight appear to move in every possible direction, yet according to the observations of Dr. Brandes and his friends, it would seem that the most frequent direction is that opposite to the course of the earth in its orbit.—*Ed. Phil. Jour.*

6. *Comparative durability of Marble and Granite.*—A fragment of a column in the ruins of Capernaum, mentiontioned by Prof. Hall, is of an extremely beautiful granular marble, which has all the freshness and brilliancy of a specimen recently taken from a natural quarry. It has been full proof against the attacks of the elements, during the lapse of perhaps two thousand years. Although limestone is softer than granite, it is frequently less liable to decomposition. This remark accords with the observations of several travellers in Egypt, Greece, and Palestine. The feldspar of the granite is affected by the action of the air and moisture, sooner than either of its other ingredients. "Of all natural substances used by the ancient artists," says Dr. Clarke, "Parian marble, when without veins, and therefore free from extraneous bodies, seems to have best resisted the various attacks made upon Grecian sculpture. It is found unaltered, when granite, and even porphyry, coeval as to their artificial state, have suffered decomposition.—*Ed. Phil. Jour.*

7. *On the Iron in the Cruor or red part of the Blood.*—Englehart of Göttingen, from a series of experiments, concludes, that the red color of the cruor of the blood is owing to iron, although this opinion has been controverted by Brande, Vauquelin and others. He found, when the cruor is deprived of its iron, that it becomes colourless. The iron is separated from the cruor by means of chlorine, a method much superior to those at present in use.—*Ed. Phil. Jour.*

8. *Manufacture of Paper from Marine Plants.*—It is said, that it has been tried with success in Holland, to manufacture paper of marine algae. We have not seen this paper, and are unable to say any thing, with certainty upon the subject, but we entertain no doubts, regarding the success of such an undertaking, provided it were conducted by proper hands. The tenacious texture, and the nature of these plants, seems to render them well adapted for this purpose.—*Ed. Phil. Jour.*

9. *Manufacture of a Paper, which has the property of removing Rust from articles of Iron and Steel.*—After having dried a certain quantity of pumice stone among live coals, and reduced it to powder, grind it with linseed oil varnish, and then dilute it with the same varnish, until it is thin enough to be laid upon paper with a pencil. To give this layer, a yellow, black, or brownish red color, the mass is mixed, before applying it to the paper, with a little ochre, English red, or lamp black. Care must be taken to lay the substance on as equally as possible, and to dry it in the air. When the first coat thus applied to the paper is dry, another is to be laid on in like manner. Those who manufacture it for sale, pass the paper thus prepared under a cylinder, to render it smooth. It is further to be observed, that the mass must be liquid, and that it must be stirred about before applying it to the paper.—*Ed. Phil. Jour.*

10. *On the Poisoning of Plants.*—Plants are liable (as Carraderi has seen) to lose their power of contraction, by the action of distilled oleander water; thus this water, or even better, the volatile oil of oleander, extinguishes all the power of contraction of the capsule of *momoidaca elaterium*, and of *balsamina impatiens.*

Mr. Marcet, of Geneva, having soaked sensitive and other plants in an aqueous solution of opium, remarked, that it also extinguished the action of vegetable life. Thence, Carradori concludes, that plants have contractable muscular fibres. Mr. Marcet has thought that vegetables also possess something analogous to a nervous system, since the first of these poisons acts on contraction, the second on the sensibility in animals.—*Jour. de Pharm. Ann. of Phil.*

11. *Raining Trees.*—In the ancient histories of travellers in America, and also by Thévet in his Cosmographia, mention is made of a tree which attracted the clouds from the heavens, and converted them into rain in the dry deserts. These relations have been considered as fables. There has lately been found in Brazil a tree, the young branches of which drop water, which falls almost like a shower. This tree to which Leander has given the name of *cubea pluviosa*, is transferred by M. Decandolle to the genus *cæsalpinia* (pluviosa,) in his *Prodromus*, vol. II. p. 483. Also, many vegetables, as the *calamus rotang*, and tender climbing plants, the vine, and other twigs, at the season of sap, *weep* abundantly, particularly when they are cut.—*Jour. de Phar. Ann. Phil.*

12. *Phosphorescent Plants.*—Several cryptogamous subterraneans, have been observed to be luminous in the dark. M. Neas, of Esenbeck, cites after M. Heinzman, the rhizamorpha phosphorescent found in the mines of Hesse, in the north of Germany; the light is visible at the extremities of the plants, especially when it is broken. This phosphorescence disappears in hydrogen gas, oxide of carbon, and chlorine gas. Some other *rhizmorpha* as the *subterranea* and the *acidula*, have also appeared phosphorescent, to several persons working in the mines.—*Jour. de Pharm. Ann. Phil.*

Extracted and translated by Prof. J. Griscom.

13. *Instruction in Geography.*—M. Alexander De Humboldt is on the point of opening in this place, (Berlin,) a course of instruction in physical geography. The influx of persons who have inscribed their names as attendants upon his lessons is so great that the Hall is found insufficient to receive all the auditors. M. De Humboldt, who is acquaint-

ed with the fine establishment in Paris, called the Georama, regrets that there is not in Berlin one of the same kind. This would enable him to exhibit to the audience on a chart of vast dimensions the different voyages of discovery, and give a sort of *instruction* of the terrestrial globe, considered at one view both in its locality and in its details. Comparative geography is, like comparative anatomy, a new science, eminently calculated to advance the geographical sciences.—*Rev. Encyc. Oct.* 1827.

14. *Homage rendered by power to genius.*—A short time since the town of Weimar, presented to the literati of Europe a scene extremely touching. The patriarch of German literature, the illustrious GOETHE, received the homage of a monarch, a true friend of the arts and sciences, who is himself one of the most enlightened men of Germany, and who omits no occasion of manifesting the noble enthusiasm which animates him on behalf of generous principles. The king of Bavaria having learned that the anniversary of the birth of GOETHE was about to be celebrated, went to Weimar, unexpectedly to the poet, pressed him in his arms, and hung around his neck the grand cordon of the order of Bavaria with which he was invested.

On his return to Munich, the young prince expressed, in an ode, the lively impressions which he felt on leaving Weimar, and in which he bestows a solemn homage to poetry; to the Grand Duke of Weimar, Charles Augustus; and to GOETHE, his illustrious friend.

This ode, in the true spirit of the German language, contains much depth and grace of imagination, and great precision of style.—*Ibid.*

15. *Marseilles*, (France.)—The *Society of christian morals*, established at Marseilles, about fifteen months since, has, even in this short space of time, by its untiring charity, rendered important services to suffering humanity. A stranger to all party spirit, indifferent to all national rivalships, enquiring into no man's religious opinions, it advances silently to the practice of well-doing, intent only upon the means of obtaining some amelioration, moral or physical in the lot of humanity. This society aspires only after a single object—the happiness of men; and its generous intentions, which embrace at once, the warrior and the man of letters, the la-

borer as well as the philosopher, the Jew as well as the christian, are so well known, and so evident, that no reasonable person can entertain the least doubt with respect to it.

This declaration of the principles which govern the society, renewed by M. Chasson, one of its secretaries, at the meeting of the 27th of September, 1827, was followed by a report upon the situation of the society and the results already obtained. Afflicted by the fury with which so many persons yield to an excess of gambling, and the misery occasioned by this detestable passion, the society ordained a prize for the best work against this shameful vice. The number of competitors was considerable; but the prize was adjudged, and the society doubled its value for the next year. It will be three hundred francs.

The society had conceived the project of forming, in Provence, a colony composed of Greeks expelled from their country, without a home and without resources; but circumstances, which could not be foreseen, occasioned the postponement of this interesting project; but the hope is cherished of resuming it next year. In the mean time, the society has extended its care to the young orphan Greeks, and it is estimated that a capital of one hundred and forty-four thousand francs will be necessary for this charitable purpose, within the year. But this sum is very small compared with the number of unfortunate beings which require assistance, and the society of Marseilles invites the other inhabitants of France to unite in this work of mercy.—*Rev. Encyc. Dec.* 1827.

16. *Figure of the Earth.*—M. Biot read a memoir on this subject, before the Institute, on the 3d of November last. His own observations, confirming the results at which many others have arrived, have induced him to admit that the action of gravity is not the same at all points on the same parallel, and that there is not a uniform variation on the same meridian. He has discovered that at Paris, particularly, the annual variation is sufficiently great to occasion a daily variation of five seconds in the going of a clock. He thinks that this variation in the force of gravity on the same parallel, is the cause of the different measures assigned to the flattening of the earth. He points out the manner in which it will be proper hereafter to direct observations on the length of the pendulum, to render them as useful as possible. Every isola-

ted observation, will in his opinion, be hereafter of little consequence, unless, by a chance on which it would be unsafe to rely, it should happen to be made at a point where the action of gravity would be a *maximum* or a *minimum*. In general, observers should hereafter endeavor to repeat their observations, either along the same parallels, or on the same meridian, in order to ascertain the laws (if any such exist) which regulate the diversity which can now no longer be contested. The author concludes his memoir in observing that the English have erred in taking the length of the pendulum as the basis of their metrical system, as this length may vary from causes which are quite independent of mere topographical position, and which may not remain constant at the same place during a course of ages. On this account, the basis of the French measure is not liable to the same inconvenience to the same extent.—*Idem.*

17. *The Society of Encouragement at Paris, offer the following premiums.*—3000 francs, for a black dye for hats which will resist the prolonged action of the sun's rays, without losing its lustre, or altering the suppleness of the fabric.

2000 francs for a cheap and effectual mode of preserving ice for domestic purposes.

1500 francs for a Rasp, which will reduce six hundred Kilogrammes (one thousand six hundred pounds troy,) of beet roots to a pulp, with the force of four men. And 2000 francs for the best press, which will extract seventy-two to seventy-five per cent of juice from the pulp.

2000 francs for the perfection of the method of producing *Ichthyocolla.*

6000 francs for an economical process of making solid pieces of ultramarine, equal to that which is obtained from lapis lazuli.

5000 francs for a process for drying meat, which will secure it from putrefaction or taint in long southern voyages. A portion of meat has been exposed during ten years, in the mint at Paris, in a situation in which it is not protected either from dust or atmospheric changes, and which after being washed and cooked, is still savoury and good. It was dried or preserved by *M. Vilaris*, an apothecary of Bordeaux, whose secret died with him.—*Programmes des pris. &c.*

18. *Action of the Moon on the Atmosphere.*—The Bib. Univ. for Dec. 1827, contains a valuable memoir on this subject by M. FLAUGERGUES, astronomer at Viviers in France. The author observes that many geometricians, have been engaged in researches on the action of the moon upon the barometer, but that their labors have not been attended with very satisfactory results. Nor have the labors of meteorologists been much more successful. The observations of some of these are contradictory and irreconcilable with each other. Several have inferred that the barometer is higher during the time the moon is in perigee than when she is in apogee; and others, that the mean height is greater in the syzygies than in the quadratures; but other observers, have drawn opposite conclusions. The results of different years do not correspond. The fault may in many cases have lain in the instruments, which for want of proper care and management are liable to deteriorate. Considering also the many irregularities, which attend the moon's motion, it is only by a long series of observations, that correct and satisfactory deductions can be formed. The author describes at length the instruments he employed, and the precautions which he observed to ensure accuracy in his observations. He extended his researches throughout a whole *Saros* or lunar cycle, and sums up the result as follows:—

Table of the mean heights at noon, of the barometer, at the observatory of Viviers, in the phases of the Moon, in the Apogee and Perigee of that luminary, and in the lunistices; deduced from the meridian observations of nineteen years, (19*th Oct.* 1808—18*th Oct.* 1827.)

LUNAR POINTS.	Number of observations.	Mean heights of the barometer.	Reduction to millimetres.
		pou. lig.	m. m.
Mean general height, - - - - -	6915	27 11.29	755.44
Conjunction, or new Moon, - - - -	234	27 11.27	755.39
First Octant, - - - - - - -	234	27 11.26	755.37
First quadrature, - - - - - -	234	27 11.26	755.37
Second Octant, - - - - - - -	235	27 10.94	754.65
Opposition, or full Moon, - - - -	234	27 11.20	755.23
Third Octant, - - - - - - -	234	27 11.47	755.70
Second quadrature, - - - - - -	234	27 11.68	756,32
Fourth Octant, - - - - - -	235	27 11.31	755.48
Northern Lunistice, - - - - - -	258	27 11.42	755.73
Southern Lunistice, - - - - -	258	27 11.28	755.42
Moon in Perigee, (Parall. equa. 60′ 24″)	252	27 10.97	754.72
Moon in Apogee, (Parall equa. 54′ 4″ -	252	27 11.46	755.82

It evidently appears from this table,

1st. That in a synodical revolution of the moon, the barometer rises regularly from the second octant, when it is the lowest, to the second quadrature, when it is the highest; and then descends to the second octant to commence again its rise, &c.

2d. The varying declination of the moon also modifies her influence upon atmospheric pressure. It is greatest (at least in the latitude of Viviers,) when the moon's declination is south; whence it evidently results that the barometer is higher in the northern lunistice than in the southern. This observation is contrary to what M. de Laplace had concluded from his theory, viz. "that the sign (signe) of the declination of the two luminaries (sun and moon) has no sensible influence on the modifications of the atmosphere."*

3d. Lastly, the action of the moon, in diminishing the pressure of the atmosphere, varies with its distance from the earth. The mean height of the barometer is less when the moon is in perigee than in apogee, whence we may infer that her action in diminishing pressure, is greater in the former than in the latter situation.

There exists between the phases of the moon and the days of rain which coincide with these phases, a constant relation which would appear very singular, if what we have observed with respect to the barometer did not furnish an immediate explanation. Agreeably to the extract which I have made from my meteorological journal of the rainy days which coincide with the days of the moon's phases and with those of the perigee and apogee during the period of nineteen years, I have found the number of those days as follows.

	PHASES OF THE MOON.					
	New Moon.	First quarter.	Full Moon.	Last quarter.	Perigee.	Apogee.
No. of rainy days coincident with the days of the Moon's phases.	77 days.	82 days.	79 days.	60 days.	93 days.	78 days.

We perceive by this table that the number of rainy days which coincide with the days of the phases, &c. follows the same march with the mean heights of the barometer corres-

* Mécanique celeste, t. ii, p. 298.

ponding with these phases, but in an *inverse order:* thus the number of days of new moon on which it has rained, is less than the rainy days of the full moon, and the mean height of the barometer on the days of conjunction is greater than that of the days of opposition; in like manner the rainy days of the first quarter greatly exceed those of the last quarter, and the barometer heights are also inversely correspondent; lastly the wet days of the perigee are much greater than those of the apogee, and the barometer follows a correspondent change.

We may therefore conclude that the diminution of the pressure of the atmosphere caused by the attraction of the moon, ought to be reckoned among the causes which determine the fall of rain.—*Viviers*, 19 *Novem.* 1827.—*Bib. Univ. Dec.* 1827.

19. *Helvetic Society of Natural Sciences, held at Zurich on the 20th, 21st, and 22d of August*, 1827.—M. Debur, of Geneva, furnished a table of meteorological observations of his father, exhibiting the years remarkable for heat from 1768 to 1800.

Maximum of the thermometer after noon.—F.			Maximum of the thermometer after noon.—F.		
1771,	July 25,	91°	1792,	July 19,	90½°
"	" 26,	92¾	1793,	June 30,	90½
1780,	July 30,	90½	"	July 18,	94½
"	" 31,	95	"	" 17,	98¼
1781,	May 31,	83¾	1794,	July 7,	88¼
"	Aug. 28,	80	"	" 23,	92¾
"	" 31,	79¼	1797,	July 19,	90½
1787,	Aug. 1,	92¾	"	" 21,	90½
1791,	July 28,	90½	1778,	Aug. 4,	91½
"	" 31,	90½	"	" 13,	98
"	Aug. 1,	92¾	"	" 14,	98
"	" 8,	89¼	1800,	Aug. 14,	92¾
1792,	July 18,	90½	"	" 19,	95

1780. The vintage took place at the end of September, and the wine was of a superior quality.

1781. Wine of same superior quality.

1791. The harvests all suffered by drought, except that of the wine.

1800. The grass withered on the mountains.

An examination of the intervals which separate the years remarkable for great heat, shows that their return is subject to no regular law; sometimes the intervals are very long, sometimes very short: thus in the last thirty years, they are nine, seven, four, two, one and six years.—*Bib. Univ. Dec.* 1827.

20. *Necrology.*—The following are the epochs of the death of the philosophers whose names are mentioned.

Schubert, - - -	22d October, 1825.
Fuss, - - - -	23d December, 1825.
Reichenback, - -	12th May, 1826.
Frauenhofer, - -	7th June, 1826.
Bode, - - - -	23d November, 1826.
Laplace, - - -	5th March, 1827.
Volta, the same day with Laplace.	
Chladni, - - -	4th April, 1827.
Ramond, - - -	14th May, 1827.
Fresnel, - - -	14th July, 1827.

Ferrussac's Bul. Juillet, 1827.

21. *Sideroscope.*—An instrument has been invented in France to which the above name has been given, provisionally from the extreme facility and delicacy with which it indicates the smallest portion of iron in any substance, mineral, vegetable, or animal.

It consists, briefly of a small straw, nine inches long, through one end of which pass at right angles, two fine sewing needles, sixteen lines in length, both strongly magnetised, weighing only one grain. They are inserted in contrary directions. Through the other end passes a single sewing needle, of the same length, weighing a grain and a half, magnetised in the same manner. This instrument is suspended inside of a glass case, by a single untwisted fibre of raw silk, twelve inches long; substances to be examined, are introduced into the case, by a lateral opening. The whole instrument weighs but four grains, and the utmost care is observed to exclude from the frame or table of wood which supports it, the smallest particle of iron, and to avoid the disturbing effects of a current of air, and even of the breath.—The substances to be presented for trial, are pasted to a small strip of card or pasteboard, to avoid the heat of the hand or fingers.

Almost every piece of money, French or foreign, ancient or modern, gold, silver or copper, but especially the silver coins of Italy, attracts the sideroscope with greater or less activity: it is the same with all substances, mineral, vegetable or animal, which contain the least atom of iron, nickel or cobalt. Platina exercises a decided action, notwithstanding all the chemical operations necessary to bring it to a soft state.

Small masses of any of the following substances, weighing at most, eight or ten grains, affect this delicate instrument. All kinds of ashes, compacted by a little gum water; blood simply dried or swelled; chocolate; bottle glass; tourmalines, green and black, not rubbed or warmed; granite; rhomboidal quartz; yellow topaz; green talc; sulphate of iron; all volcanic products; all metals not chemically pure; brass pins, even the finest used by entomologists; various galenas and other minerals; all ærolites; burnt hoofs and horns of cattle, &c.

The most surprising effect of the Sideroscope is the *repulsion* of the needle by bismuth and antimony.—*Idem.*

22. *Purity of Tin.*—M. Oehngern undertook in 1822, the analysis of the various kinds of tin employed in the manufacture at Closter of sheet tin (fer-blanc) in order, to discover the cause of the superiority of certain kinds. He discovered that the English grain tin, which gives the finest tinned surface contains no foreign body.

M. Rinman, who has rendered great service to the Closter fabric, has been engaged in the examination of the saline residuum obtained in the purification of common tin in order to render it fit for tinning. He finds in the 100 parts,

Tin, - - - - -	85.3000
Copper, - - - - -	13.7178
Iron and Zinc, - - - -	.3300
Arsenic, - - - - -	.6712

He concludes that to the arsenic, and especially to the copper, ought to be attributed the property which impure tin possess of losing its lustre when used in tinning other metals.—*Ibid.*

23. *Prussian Blue.*—M. Gautier in his theoretical researches into the formation of cyanogen has been led to the following conclusions. First, calcined animal matter will

alone give very little cyanogen. Second, it produces more with potash, but the prussiate is not ferruginous. Third, ammonia is then produced in great quantity. Four, the substitution of nitre for potash and the addition of clippings or scales, (vattitures) increase the production of cyanogen, and give a ferro-prussiate. The author has practised this process for two years in the neighborhood of Paris. His method as he describes it is as follows,

Blood, supposed dry, - - -	3 parts.
Nitrate of potash, - - -	1 part.
Scales of iron, - - - - -	$\frac{1}{50}$ of the blood.

After having coagulated the blood in a large copper kettle the serum is pressed out and the clot returned to the kettle, with the nitre and the iron. The humidity of the blood is sufficient to liquefy the salt, so that the mixture becomes uniform. It is then removed to an airy loft, where the desiccation is completed. The putrefaction of the blood is prevented by the nitrate of potash. When completely dry it is put into cast iron cylinders, arranged in a reverberatory furnace similar to those used for ivory black. The cylinders are heated to dull red, or until smoke ceases to be disengaged. The materials after being thoroughly cooled, are withdrawn, and put into a wooden vat, with twelve or fifteen times their weight of water, and left one hour. The fluid is then filtered through a cloth and evaporated to the thirty-second degree of Baumé's areometer. On cooling, a considerable quantity of the bicarbonate of potash is produced, in well formed crystals. The author has not been able to satisfy himself with respect to the manner in which this bicarbonate is formed at so high a temperature, since a portion appears to be decomposed during the evaporation of the ley, at first, but little alkaline, but which becomes very sensibly so, by a prolonged evaporation.

The same product is not obtained when the potash of commerce is used. It is probable that the elements of the nitric acid act an important and necessary part in this operation.

The solution which has furnished these crystals, contains a little sub carbonate of potash and much cyanuret of ferruretted potassium. The liquor is contracted to 34. placed in wooden vessels cased with lead. In the course of a few days a greenish crystalline mass is obtained: these crystals are re-dissolved in a fresh quantity of pure water, which evaporated to 32 or 33, yield crystals anew.—*Ibid.*

24. *Saltpetre.*—It is stated by Henri Braconnot, that the stem and leaves of the common Beet when dried and burned, yield ashes so rich in alkali, that it melts easily by heat, and surpasses many of the commercial varieties of potash. Beets which grow in a soil highly manured contain much nitre; those which grow in thin and sandy soils, very little. The leaves of the former when tied in bundles, and hung up to dry in places slightly moist, warm, and rather dark, will have their leaf stalks entirely penetrated and covered with an innumerable multitude of small crystals of saltpetre. The nitric acid, in this case must have entirely displaced the oxalic and malic acid. Is this acid formed under the influence of the animalised substance contained in the petioles, or is it produced exclusively by the elements of the atmosphere? The author tried in conjunction with a friend, to manufacture saltpetre from the residue of the beets used in a sugar factory but was not successful.—*Ann. de Chimie. et de Physique*, *Juillet*, 1827.

25. *Evaporation of water from hot surfaces.*—It was ascertained by LEIDENFROST, in 1756, that between the boiling point and that at which iron becomes white hot, water evaporates from its surface less easily the greater the heat. Klaproth repeated these experiments and relates the result as follows.

A polished iron spoon being heated to whiteness, and a drop of water being let fall upon it, the drop split into pieces, but these were soon united again, and appeared like a crystal ball in a state of repose, touching the hot metal only in one point. On observing it closely, it was found to turn rapidly round its center, becoming smaller and smaller until it was dissipated with explosion. As soon as it was gone, he let fall another, and then a third, fourth, &c. the spoon cooling the whole time.

The first drop continued	40	seconds,
the second - -	20	"
third - -	6	"
fourth - -	4	"
fifth - -	2	"
sixth - -	0	"

Having let fall seven drops in a spoon heated to the proper point, they united in a globular mass which began to turn on its axis with rapidity. It afterwards separated at the top, and a spot of white foam appeared, the borders being indented. This curious phenomenon continued one hundred and fifty seconds. Ten drops formed a globule with like results, except that it lasted two hundred seconds, and went off without evaporation properly speaking, the spoon being very hot.

After these trials he used a capsule of pure silver and another of platina, which were heated on coals to whiteness. The phenomena were nearly the same. With the silver capsule, in the first experiment

the first drop continued	72	seconds,
the second - -	20	"
third - -	20	"
fourth - -	0	"

In the second experiment

the first drop continued	61	seconds,
the second - -	30	"
third - -	20	"
fourth - -	6	"
fifth - -	0	"

When there were three drops, the united ball continued two hundred and forty seconds, and the evaporation was afterwards instantaneous. With the platina capsule, the first drop continued fifty seconds, and a bubble of three drops ninety seconds.—*Ibid.*

26. *Contents of rain water.*—M. Liebig, professor of chemistry at Geissen, found on an examination of seventy-seven specimens of rain water, seventeen of which were procured during storms, that the latter all contained nitric acid in very different quantities, combined either with lime or ammonia. Among the other sixty specimens he found but two which contained a trace of nitric acid.

The same chemist examined the residue of fifty other varieties of rain water, collected by the late M. Zimmerman, in 1821, 1822, and 1823; among them twelve contained nitrates.

It thus appears, that during storms the azote and oxygen of the atmosphere, combine and form nitric acid—a fact by no means surprising, after the experimental results of Cavendish and Seguin.

Hence when nitrates are found in materials which contain neither animal nor vegetable matters, the acid is probably formed by the electricity of the atmosphere.

A memoir of Luiscius, (Rotterdam, 1798,) on the putrefaction of vegetable and animal substances, states, 1st, that these substances, in contact with water, are entirely decomposed, if the air have free access; 2d, that the decomposition is singularly accelerated by air; 3d, that under those circumstances, (air and water having free access,) much nitric acid is produced, and a little ammonia; 4th, that these substances putrefy in different times in the following order; urea, gluten, animal gelatine, muscular fibre, starch, white of eggs, gum, sugar, vegetable fibre, &c.—*Ibid.*

27. *Presence of ammonia in argillaceous minerals.*—It is the conclusion of M. Bouis, of Perpignan, from his experiments and researches, that the argillaceous odor of minerals is owing to the presence of ammonia. He has found it in pipe clay, impure gypsum of various formations, steatitic earths, anterior to the presence of organised bodies, &c. When these substances are moistened with a solution of caustic potash, the argillaceous odor is generally increased, and in that case a glass wet with hydro-chloric acid occasions white vapors when held near them. Litmus paper, slightly reddened, and placed over these earths, thus moistened, has its blue color restored.

Argillaceous odor has been generally ascribed to the oxide of iron, but it is difficult to conceive how this substance can render inert substances odorous. The presence of ammonia in these minerals may account for the odor they give out on being breathed upon, or slightly moistened. The ammonia becomes the vehicle of the peculiar argillaceous material.

An analogous phenomenon occurs in musk, tobacco, &c. which when perfectly dry, are almost inodorous but when moistened with a weak solution of ammonia, give out their characteristic odor.—*Ibid.*

28. *Magnetism.*—M. Seebeck, in making new researches on the property which the metals have of diminishing the number of oscillations of the magnetised needle, determined the different degrees of this force in each metal. He used a needle two and one eighth inches long, suspended by a fibre of silk, at the distance of three lines over metallic plates and observed that between the two amplitudes of 45° and 10° it made

116 oscillations above a plate of marble.				
112 over a stratum of mercury	2	lines	thick.	
106 over a plate of	Bismuth,	2	"	"
94 - -	Platina, -	.4	"	"
90 - - -	Antimony,	2.0	"	"
89 - -	Lead, -	.75	"	"
89 - - -	Gold, - -	.2	"	"
71 - -	Zinc, - -	.5	"	"
68 - - -	Tin, - -	1.0	"	"
62 - -	Brass, -	1.0	"	"
62 - - -	Copper, -	.3	"	"
55 - -	Silver, - -	.3	"	"
6 - - -	Iron, - -	.4	"	"

The author ascertained by experiment, that the metallic nature of the magnetic needle had the same influence on the oscillations as subjacent plates, and that by combining the metals, which, like iron, nickel and cobalt, are magnetic, with others, which, like antimony, diminish the magnetic force,—compounds are formed, which have no influence on the oscillations of the magnetic needle. He thus found that an alloy of 4 parts antimony with 1 of iron, of 3 copper with 1 anitimony, and of 2 copper with 1 nickel, produced not the least dimunition in the number of oscillations which were 116 as when over a plate of marble. He infers from these facts that those three alloys, would be the most suitable for compasses, and that that of copper and nickel deserves the preference, from its being the most malleable. —*Ferrussac's Bull. Aout*, 1827.

29. *Artificial Spider's web for micrometers*—Dissolve, to a convenient extent very thin caoutchouc in very pure spirits of turpentine. By drawing out the solution, extremely fine and smooth threads are obtained, which when dried, are very good for micrometers.—*Ibid.*

30. *Analysis of Potteries.*—M. P. Berthier has examined the composition of several kinds of pottery ware. He distinguishes them into three sorts—1st, porcelains, 2d, potteries, 3d, crucibles.

	PORCELAIN.			
	Sèvres.	England.	Piedmonts.	Tournay.
Silica, - - - -	0.596	0.770	0.600	0.753
Alumine, - - - -	0.350	0.086	0.090	0.082
Potash, - - - -	0.018	- -	- -	} 0.059
Soda, - - - -	- -	- -	- -	
Lime, - - - -	0.024	0.012	0.016	0.100
Magnesia, - -	- -	0.070	0.152	- -
Water, - - - -	0.008	0.056	0.136	0.006
	0.996	0.994	0.994	1.000

The paste of Sèvres is composed of
.633 of kaolin of Limoges, washed;
.105 of quartzose sand from the mound of Aumont;
.052 of chalk from Bongival;
.210 of fine sand extracted from the kaolin by washing; this sand is a mixture of quartz and feldspath.

The porcelain of Sèvres is known to be of an excellent quality, and as refractory as any in Europe.

The glazing is made of a rock composed of quartz and feldspath, reduced to a very fine powder. It is composed of

Silica, - - -	0.730	} 0.982
Alumine, - - -	0.162	
Potash, - - -	0.084	
Water, - - -	0.006	

It melts into a perfectly transparent and colorless glass.—*Annales des Mines. T. I.* 469.

31. *On the measure of the intensity of Light.*—The most general method is to place an opake body before a white card or pastebord, in front of the two lights to be examined, to remove the latter from the screen until they produce shadows of equal intensity, and then to take the squares of the distances as the relative powers (inversely) of illumination.

It has been found that the apparent intensity of the two shadows varies with the position of the observer. If they are equal when observed from a point situated perpendicularly over the screen and equidistant from each shadow, they will, if viewed from any other point appear to vary in intensity, the nearer having the deeper shade, so that in changing from right to left of the table, each will appear in its turn of the deeper hue. These differences are greater in proportion to the distances of the shadows from each other and the smoothness of the surface of the screen. Hence in photometrical observations, screens should be used which are not very smooth, and the shadows should be brought near each other; and even so as to allow their borders to touch.—*Ferrusac's Bull. Oct.* 1827.

32. *Impurity of rain water.*—In evaporating thirty ounces of rain water every month, which at the end of the year amounted to three hundred and sixty ounces, M. Brandes obtained a total residuum of 2.75 grains. It was composed of resin, pyrrhin, (a vegeto-animal substance,) mucus, hydro-chlorate, sulphate and carbonate of magnesia, hydro-chlorate of soda, sulphate and carbonate of lime, hydro-chlorate of potash, oxide of iron and manganese, and an ammoniacal salt.—*Ibid.*

33. *Sulphur in assafœtida.*—In treating assafœtida with caustic potash, and adding an acid to the solution, effervescence is produced, and a gas disengaged which colors paper of acetate of lead like sulphuretted hydrogen.

If an alcoholic solution of assafœtida be evaporated, and the residuum be treated with aqua regia, a liquid is produced which contains sulphuric acid.

In burning the volatile oil of assafœtida in a pure state, a very strong odor of sulphurous acid is developed. This oil, heated to redness with potash, produces a mixture of charcoal and sulphuret of potash. M. Zeise presumes that his ulterior researches will enable him to discover sulphur in a great number of organic substances. It may be remembered also that M. Planche has already detected the presence of sulphur in the umbellifera.—*Ibid.*

34. *Incompatible salts.*—M. Brandes has demonstrated by means of an artificial mineral water, that the waters of Pyrmont contain carbonate of soda and sulphate of lime, and not, as has been pretended, sulphate of soda and carbonate of lime; because if these latter salts co-exist, even in a large quantity of water, a material decomposition takes place.—*Ibid.*

35. *Steam Engines in Great Britain.*—It is confidently asserted that there are now in Great Britain, fifteen thousand steam engines. Some of them are of prodigious size. In the county of Cornwall, for example, there are some of the

power of six hundred horses. Admitting that on an average, they are equal to twenty five horses each, the total strength of these engines would amount to that of three hundred seventy five thousand horses. Now, agreeably to the estimate of Mr. Watt, a horse is equal to five and a half men. England, therefore, possesses in these engines, a force of about two millions of men. It may be further observed, that as each horse requires annually, the produce of two acres of land for his nourishment, the inhabitants of that nation have, by means of steam engines, seven hundred and fifty thousand acres more at their disposal than if the same labor were executed by horses.—*Ibid.*

36. *Crystal Bed.*—The public have been hastening to the palace de Tameda, to see a bed of massive crystal, destined to be sent as a present to the shah of Persia by the emperor of Russia. This magnificent bed, the only one of the kind perhaps in the world, is resplendent with silver, ornamented with columns of crystal, and ascended by steps of blue glass. It is constructed in such a manner that there can be made to issue from it, on each side, jets of odoriferous water, whose murmuring sounds may excite an agreeable slumber. It reflects by the light of flambeaux a dazzling splendor resembling myriads of diamonds. There is no doubt that this piece of furniture will astonish even eastern luxury and magnificence. It was made in the Imperial manufactory of St. Petersburg.—*Annales patriotiques, Oct.* 1825.—*Ibid.*

37. *Compressibility of water, by Prof. Oersted.*

1. As far as the strength of my apparatus allowed me to urge the compression of water, (viz. to seventy atmospheres,) I have found the compressibility proportionate to the compressing force. The compression produced by a single atmosphere, already discovered by Canton, is about forty five millionths of the whole volume. Mr. Perkins has obtained by a pressure of one hundred atmospheres, a compression of one hundredth of the entire volume, which is much more than can be inferred from my experiments. Calculating from the results I have obtained with pressures below seventy atmospheres, I obtain for one hundred atmospheres only 0.0045. Finding that my results differed so widely from the distinguished mechanician's who preceded me, I have repeated my experiments with the greatest care, and they are so simple that I can entertain no doubt of their correctness.

2. As far as I have been able to determine the temperature of compressed water, and I have done so to the extent of forty eight atmospheres, I have found no heat disengaged by compression.

3. The compression of mercury is but little more than a millionth of its volume for one atmosphere.

4. The compressibility of sulphuric æther is about triple that of alcohol, double that of sulphuret of carbon, but equal only to a third of that of water.

5. The compressibility of water, holding salts, alkalies and acids in solution, is less than that of pure water.

6. The compressibility of glass is excessively small, and far below that of mercury.—*Ibid.*

38. *Probability of Life. Comparative results deduced from Registers kept at Geneva, and calculations made by Dr. Odier.*—It appears from these registers that the probability of life, as well as its average period, has been continually increasing from the sixteenth century to the year 1826, particularly in its earliest stages; and that there is a slight diminution in the subsequent periods, but which is far from balancing the former gain. It is thus very manifest that the cares bestowed upon infancy have ameliorated its existence, and that children are now preserved in a very remarkable proportion. These successive improvements will be obvious from the following table.

	Probability.		Proportion.	Average life.		Proportion.
	Yrs.	Months.		Yrs.	Months.	
16th century,	4	9	100	18	5	100
17th do.	7	11	$166\frac{2}{3}$	23	4	$126\frac{1}{2}$
1701 to 1760,	27	3	$573\frac{2}{3}$	32	8	$177\frac{1}{3}$
1761 to 1800,	32	4	$680\frac{2}{3}$	33	7	$182\frac{1}{3}$
1801 to 1813,	37	10	$796\frac{1}{2}$	38	6	209
1815 to 1826,	45	10	$964\frac{9}{10}$	38	10	$210\frac{3}{4}$

The probability of the life of women, has always been superior to that of men, and agreeably to a table prepared by Dr. Odier, from the mortuary register of 1801 to 1813, married women and widows have a superiority over others, with respect to the average of life in the ratio of $112\frac{7}{10}$ to 100, notwithstanding the risques of child birth. He estimates the number of women, who perish from this cause, to be one hundred and twenty five in ten thousand, or one to eighty.

The regularly increasing ratio, which the tables present, authorize the opinion of a sensible amelioration in the vitality of our population, and even in our morality, for in reality, among the causes of this amelioration, may be reckoned the perfection of physical and moral education, which has in a great measure expelled the vices and excess to which an ignorant population is ever prone. To this must be added the increase of wealth and ease which is favorable to a more wholesome style of living, and contributes to that tranquility of mind which has a powerful influence on the health. The progress of *Medicine* and *Hygiene*, especially by the introduction of inoculation and vaccination has done much to promote longevity.—*Ibid.*

39. *A simple process for discovering and separating antimony from lead, brass, and other metals soluble in nitric acid; by* M. Bussolin.—If an alloy which contains no antimony be dissolved in sulphuric acid, all will be dissolved, except the tin, the white oxide of which will be precipitated; but if the alloy contain a very small quantity of antimony, the oxide of tin will become of a yellowish hue. Besides, the tin has the property of drawing away all the antimony by its precipitation in the nitric acid. These two facts have been usefully employed by the author, for the discovery of antimony, and the separation of it from the lead.—*Ferrusac's Bull. Jan.* 1828.

40. *Note upon the spontaneous combustion of Cobalt; by* M. Boullay.—Very recently, some cobalt, pulverised by mechanical means, became so strongly heated as to take fire. The combustion slow at first, and was not perceived till the end of two or three days; it was then very hot and luminous, if ever so little stirred. It was covered and set to cool. Some days after, twenty pounds of it, were packed up without any renewal of the combustion, and nevertheless, on the following night, the package of cobalt set fire to the objects with which it was in contact, and afterwards to the warehouse. The fire was extinguished.—*Ibid.*

41. *Note upon the Ioduret of Lead; by* M. Berthenot.—Iron and zinc decompose the ioduret of lead, by simple ebullition in water; the carbonates of soda, barytes, strontian, lime and magnesia, as well as the oxides, have also the property of decomposing the ioduret of lead.—*Ibid.*

42. *Observations upon some properties of sulphur; by* M. Dumas.—It is known that melted sulphur becomes thicker, the higher the temperature is raised, that just before boiling, it becomes more fluid, and that its color constantly advances to a reddish brown; that, finally, being suddenly cooled, when it has been strongly heated, it is soft and transparent, until the moment when it crystallizes. The only remark which M. Dumas appears to make, is, that it is not necessary to keep the sulphur hot a long time, but only to raise it to the necessary temperature, and to cool it suddenly, by dividing it, to reduce it to a soft state.—*Ibid.*

(Communicated by Dr. William Meade.)

43. *Death of the Hon. George Knox.*—We are concerned to have to announce in this Journal the death of the Right Honorable George Knox, F. R. S. and president of the Kirwanian Society of Dublin, who in making a scientific tour in the Tyrol last summer, was unfortunately overturned in his carriage, by which accident, he was deprived of his life, to the great regret of his numerous friends and acquaintance, by whom he was sincerely esteemed for his many amiable qualities. But by the friends of science in particular, his premature decease will be severely felt; few gentlemen of his high rank, have cultivated the sciences of Chemistry and Mineralogy, in all their branches with more zeal and ardor than Mr. Knox. The Transactions of the Royal Society of London, contain many of his papers on Analytical Chemistry. In one of their late journals, in particular, we have observed an ingenious essay of his, on the analysis of certain minerals, proving the existence of bitumen in several of those where it had not been previously suspected, and pointing out, from this circumstance, the probable cause of those discordant results, which have appeared in the Analytical enquiries of different Chemists on the same substances.

44. *Portable Gas.*—The lamps for portable gas are of all shapes and sizes; they are all of malleable iron, and, when placed in a room, are put into bronze or other cases, which combine the useful with the ornamental; the price is three farthings a cubic foot; and, we should suppose that a lamp, containing twenty cubic feet, would give light equal to that of two candles for a week, and burn five or six hours

every night. But it is not only for light that these lamps will be found useful, they will serve also for fire. By a small one, containing only twenty-five cubic feet of gas, water and eggs have been boiled, and a beaf steak very delicately dressed, every morning and evening, for a fortnight. A kettle full of water, placed over the jet, boils in four minutes. The light is found so delightful, that, we believe, many will soon give up candles altogether. With regard to any danger which the timid or the ignorant may suppose to be connected with the use of these lamps, no prejudice can be more absurd; for, even though the whole gas that any of them contains was to escape, no explosion could possibly take place, if the atmospheric air was in its natural state of healthy circulation. It is only where the atmospheric air is completely pent up, and stagnant, that it could become so impregnated with gas as to be susceptible of combustion. In no properly ventilated house is this ever the case; besides, it would only be in consequence of extreme negligence that the gas could ever escape at all; and the best of all proof that no accident *will* happen is, that no accident *has* happened.—*Edinburgh paper.*

II. Domestic.

1. *Temperature of water in wells, observed by Gen. Field.*—The following is a table of observations, made on the waters of six wells, in this village, with a view of ascertaining the various degrees of temperature at different seasons of the year. The wells were from fourteen to twenty two feet deep, (none in the vicinity being deeper than twenty two feet,) most of which I carefully examined weekly for two years. To avoid prolixity, I have taken the mean temperature of all the wells monthly, and the following is the result.

		1826.	1827.			1826.	1827.
January	15,	43°.5	43°.0	July	15,	48°.0	47°.5
February	15,	42 .5	42 .0	August	15,	49 .5	49 .0
March	15,	41 .0	41 .0	September	15,	50 .5	50 .0
April	15,	40 .5	40 .5	October	15,	51 .0	51 .5
May	15,	43 .0	43 .0	November	15,	48 .5	48 .0
June	15,	46 .0	45 .5	December	15,	46 .0	45 .5

Remarks.—From the above observations it appears, that, in this latitude, the maximum of temperature of the springs, which supply our wells with water, occurs about the 15th of October, and is about - - - - - - - 51°.

Minimum, about the 15th of April, and is about 40.

Difference, - - - - - - - 11°.

Fayetteville, (Vt.) May 26th, 1828.

2. *Proceedings of the Lyceum of Natural History, N. York.*

[Continued from Vol. XIV., p. 190.]

October, 1827.—Specimens of talcose rock *in situ*, from the serpentine locality on the island of New-York, were laid upon the table by Mr. J. Cozzens.

Mr. Gale presented a suite of specimens from the celebrated locality at Franklin, N. J. Among them were particularly noticed granular *Franklinite*, in carbonate of lime, red ores of zinc, granular *pyroxene*, and foliated Jeffersonite.

Mr. De Kay read a paper on several fossils from the Chesapeake and Delaware canal. See An. Lyc. vol. 2.

A valuable and extensive collection of scientific books was received from Prof. N. S. Castrom, of Sweden.

Dr. Torrey communicated the result of his observations on the Gay Lussite from the Province of Venezuela, of which several specimens had been recently presented to the Cabinet by Mr. Robert Stephenson, of Newcastle, (England.)

Mr. Lyle presented several ores from the Republic of Colombia, chiefly consisting of *malachite;* red and grey silver ore in its matrix.

Prof. J. Aug. Smith read a paper in which he endeavored to exhibit specific differences between the bald and grey eagles, deduced from anatomical observations.

Mr. Gale presented a large slab of *Labrador feldspar*, from Corlaers Hook, in this city.

Mr. J. Cozzens announced that he had discovered a specimen of the genus *Uranoscopus* in the American waters.

Mr. Barnes read a notice of the *Fusus corona* (Lam) from the Gulf of Mexico; a very rare shell, and now positively identified.

Dr. Torrey presented specimens of andalusite with fibrolite, and cinnamon stone, from Massachusetts; and a specimen of gold in calcareous spar, from North Carolina. This is the first example of this metal having been found in its matrix in the United States.

Mr. De Kay communicated remarks on the supposed transportation of bowlders. See vol. xiii. p. 348, of this Journal.

Mr. Moore presented specimens of the flowers of that extraordinary South American plant, the *cheirostemon pentadactylon.*

November.—Specimens of the spirea opulifolia, from Owego creek, N. Y. were laid on the table by Dr. Mitchill.

A numerous and valuable collection of minerals and shells from the Mediterranean, was received from Capt. M. C. Perry, of the U. S. navy.

Dr. Mitchill presented the fossil grinder of an Elephant, from Erie county, Pennsylvania. It was much weathered, and resembles the E. *indicus.*

Capt. Basil Hall, of the English navy, and N. A. Vigors, Esq. of London, were elected corresponding members.

December.—An extensive series of the bituminous shale of Rhode Island, containing vegetable impressions, was received from Col. Totten, of the U. S. Engineers.

A specimen of oolite, from Key West, was transmitted by Dr. Swift, of the U. S. navy; to which the attention of the society was invited, it being the first evidence of an oolitic formation with fossils in that district.

Dr. Torrey commenced his course of lectures on mineralogy.

Mr. Barnes presented specimens of shale from the vicinity of Poughkeepsie, associated with anthracite.

Rhomboidal quartz, from Putnam, Washington county, N. Y. was presented by Dr. Harris.

A valuable donation of books was received from the Prince of Musignano.

Dr. Vaché presented a large collection of minerals, plants and fishes, made by himself at Para, Brazil.

January, 1828.—Mr. Halsey commenced his course of lectures on botany.

Specimens of the Date fish, or Mytilus Lithophagus, from Minorca, with the rock containing the animals, were presented by Capt. M. C. Perry, of the U. S. navy.

Major Delafield presented a specimen of tabular spar or schaalestein, from Bustleton, Pennsylvania, and sodalite from the Rhine.

The President announced to the society that Mr. Featherstonehaugh had recently returned from Europe with an extensive and valuable collection of minerals and fossils, amounting to more than eight thousand specimens. Among them were complete series of the rock formations of England, rare fossils from the continent, specimens of all the chalk fossils of England, many of the recent new mineral species, and an extensive collection of the bones from the celebrated caves of Torquay and Kirkdale, collected by Mr. Featherstonehaugh and Prof. Buckland. It was also announced that Mr. F. had deposited in the rooms of the Lyceum an instructive series of the English fossils.

February.—Mr. Halsey continued his course of Lectures on Botany.

Specimens of iron ore were presented by Dr. Boyd from Nova Scotia, with imbedded fossil shells. The ore yields 55 per cent. of iron.

The Anniversary Meeting occurs during this month; and the annual reports of the Treasurer, Committee of Publication, Corresponding Secretary, and Librarian, presented a very gratifying view of the present state and future prospects of the Society. The following gentlemen were chosen

Officers of the Lyceum for 1828.

Joseph Delafield, *President.*
A. Halsey, *1st Vice-President.*
J. E. De Kay, *2d Vice-President.*
Jer. Van Rensselaer, *Corresponding Secretary.*
L. D. Gale, *Recording Secretary.*

March.—Specimens illustrating the geology of the French coast, near Havre, were received from Dr. Townsend.

Major Delafield presented Arragonite from New-Brunswick, N. J.; a locality not hitherto noticed.

Dr. Torrey made a report on a specimen of what is termed Marle in New-Jersey. No lime whatever is found in it; and hence its name is obviously improper.

A gigantic specimen of the Date Palm, with its sterile flowers, was presented by Dr. Hosack, and seeds from Matanzas by Mr. R. W. Otis.

Dr. Mitchill read an abstract of a work entitled "Considerations sur l'enlevement, &c. des chevaux mort."

Mr. Halsey concluded his course of Lectures on Botany.

April.—Dr. Torrey communicated a paper by Dr. Clarke containing an analysis of a substance nearly allied to Jet, very abundant in the Newark meadows. It is highly inflammable. It has been called "extract of peat" by Dr. Macculloch, who considers it as a deposit from the watery solution of peat.

Mr. De Kay read a paper on a singular mal-conformation observed in the teeth of the *Arctomys monax.* In this individual there had been a caries of the lower jaw, which had prevented the growth of the incisor on that side. Its antagonist in the upper jaw having nothing to oppose it, had continued to be developed until it had described more than one complete spiral revolution.

A new mineral, the *Haytorite*, from Haytor, Devonshire, and specimens of *Retinasphaltum*, from Bovey Heathfield, (Eng.) were presented by Mr. Featherstonehaugh.

Dr. Torrey presented a specimen of *Asphaltum*, from a marl-pit twenty miles south of Trenton, the first locality noticed in the United States.

3. *Drinking Ice-Water.*—It has long been known, that ice-water debilitates the stomach, much more than spring water of nearly the same temperature. In a tour along the Erie canal with a section of students from Rensselaer School, we made some trials with ice-water, and cold spring water, on those two very hot days, the 27th and 28th of last June. We experienced as much difference in the effect as has usually been represented, when the difference in temperature was scarcely perceptible by the hand or tongue. These tri-

als led to the following enquiry. The experiments of Black and others have shewn, that when water is brought to the freezing point, a quantity of caloric sufficient to carry the thermometer through many degrees, may be imbibed or given off, without affecting the thermometer or the sense of feeling. May not the state of ice-water be such, that though it seems to be but little colder than spring water, it will take much more caloric from the stomach? Would not this enquiry afford ample materials for a medical graduates' dissertation? A. Eaton.

4. *Virginia Aerolite.*

TO THE EDITOR.

Bremo, Fluvanna County, Va., August 4th, 1828.

Sir—The fact that stones have fallen from the atmosphere, is now universally admitted by men of science, but as there may still be some persons not acquainted with the evidence, who may entertain doubts on the subject, it may not be amiss to make known the facts connected with an instance of the sort that occured in Chesterfield county in this state about seven miles south west of Richmond, on the fourth of June last—this case is as well attested as any of the kind I ever recollect to have heard of.

Being in Richmond at the time, and hearing of the fall, I made some enquiry and obtained a piece of the stone, about the size of a pigeon's egg. This resembled so much the only specimen of a meteoric stone I had ever seen, that my anxiety to see the whole stone and to learn the facts relating to its fall, was increased. It was very much like a fragment in your cabinet which was part of a stone that fell in Connecticut many years ago,* an account of which is published in the American edition of Rees' Cyclopedia—after some enquiry I obtained the greater part of the stone weighing three pounds, three ounces, avoirdupois. Most of the exterior is of a dark grey color; about one third is covered with a black crust. The fracture is granular and of a light grey, interspersed with white metallic points, which yield easily to the knife. For several days after the stone was taken from the earth it retained a strong scent of sulphur. The exterior exhibited several cav-

* Dec. 1807—A great event of the kind—several hundred pounds of stone fell—during the passage of the fire ball.—A specimen in the Cabinet of Yale College, weighs 36 lbs.—Editor.

ities from the size of a pea to that of a mustard seed; many of these are filled with earth and with fibres of the turf through which it passed on striking the earth. The whole stone, when entire, was said to have weighed about four pounds. Its form is nearly spheroidal and its specific gravity about 4.

The facts in relation to its fall, as I obtained them from a friend who visited the spot on the 7th of June, (the day after I got possession of the stone,) are as follows.

An overseer and several negroes were at work in a field belonging to a Mr. Matthew Winfree, about 9 o'clock on the morning of the fourth—an explosion was heard in the direction of Richmond towards the north east, which was at first mistaken for the report of a cannon, and in a short time after, there was a noise which was thought at first to be the rumbling of a carriage on a neighboring stony road. In a few seconds however it was perceived to be rapidly approaching, and presently after, seemed to be just over head, when it passed beyond, and ended by a sound resembling the fall of a heavy body on the earth—the persons hastened towards the place from which the stroke proceeded, and after considerable search, found a hole in the turf which seemed to have been made by the entrance of a ball; they dug, and got the stone above described. The stone had buried itself about twelve inches—the distance of the hole from the point where the persons were standing when the stroke was heard, was found by measurement, to be two hundred and sixty paces.

The person who gave the above account saw the hole the third day after it had been made. The bed from which the stone was taken was entire when he was there, and of the size and shape of the body said to have been taken from it.

A specimen will be submitted to the professor of chemistry at our University, as soon as possible. I should have taken great pleasure in sending it for your inspection but for the difficulty of getting it to New Haven.

Your most obt. serv't. JOHN H. COCKE, JR.

A promised specimen has not yet arrived.—ED.

5. *Note supplementary to Wright's Theory of Fluxions.*—In the Lemma, belonging to the demonstration of the identity of ratios in fluents and their fluxions, it is said [let AHNB be any curve whatever, and suppose DFME to be another drawn parallel to it, and consequently similar.] This will hold true only in cer-

tain cases. It should have been expressed, [and suppose DFME to be another similar to it.] Although all right lines, terminated by corresponding points in curves which are similar, are parallel; yet the curves themselves may not be parallel, as will appear evident upon a little reflection. For instance, two ellipses, that are similar, are not parallel. The subsequent train of reasoning, however, is not affected by this inaccuracy. The N. B. at the close of the theory may, I think, be more fully and accurately expressed thus: The projection is made by rays parallel to a line drawn from the nearest corner at the left hand at the top, diagonally, to the furthermost corner at the right hand at the bottom. The sides GHFE in fig. 2. and L–ON in fig. 6. stand on the plane of projection; and the opposite sides CDBA in fig. 2. and AKMP in fig. 6. are elevated. The sides ABFE in fig. 2. and PMON in fig. 6. front the reader. The sides GCAE in fig. 2. and LAPN in fig. 6. are situated on the left hand. The other sides, in the projection, fall behind and are hidden. The reader will notice that the position of the cube in fig. 6. is different from that in fig. 2. as is denoted by the letters. That the little blue cube in fig. 6. may be brought into view, the original cube is turned about, so that the side ABFE, which in fig. 2. fronts the reader, in fig 6. falls on the left hand side. E. W.

6. *Errors corrected in Dr. Robinson's Catalogue of Minerals.*—The localities mentioned in this manual, are, in many cases, not described with adequate particularity. The *township* is mentioned, but not the particular *spot* in which the mineral occurs. The traveller sometimes spends hours, and even days, in a fruitless search after it. Perhaps this marked deficiency was unavoidable. The compiler copied most of his localities from the public journals, where the same defect exists, and must have been observed by all who attentively read them.

There is another fault to be noticed. It is common to the catalogue, and to the journals. An individual discovers an interesting mineral—a small mass of fluate of lime, or lepidolite, or rose-quartz, and takes the whole, to his own cabinet, and then, publishes the locality; those who come afterwards, are of course disappointed, as the substance is not to be found in that region.

Localities of minerals should never be named in our public journals, without a statement of the quantity. This precaution would save much exertion, now thrown away.

The catalogue contains a number of *errors*, which are now making their appearance and circulating in other works, in our country. Two or three of these mis-statements, those with which my name is coupled—I will point out; and you, Sir, will do me a favor, by giving this paper a place in your

Journal. "Coccolite green and red," the catalogue informs us, is found in Charlotte, Vermont, and Professor Cleaveland is quoted for authority. If any one will take the trouble to turn to the article, in Cleaveland's valuable system of mineralogy, he will find, that reference is made to me. Indeed, the error must be charged to my account. It occurred in this manner. A Mr. Muzzy, who was attempting to manufacture at Middlebury, Vt. the Monkton porcelain earth, into China ware, gave me, in 1810, a mineral, which, he stated, came from Charlotte. I sent a part of it to Prof. Cleaveland, to be named. He called it Coccolite. I also published a brief notice of it in the Literary and Philosophical Repertory, from which Prof. Cleaveland's description is taken. Soon after this, Mr. Muzzy died. I made many enquiries after the locality of this substance, but gained no information on the subject. I have since been a number of times in Charlotte, and endeavored myself to find it, but always failed of success; and I now state, *that I have no knowledge of the existence of Coccolite, in that township.*

Dr. Comstock asserts in his Mineralogy, that Coccolite "is found *in abundance*, and of various colors," in Charlotte, and gives my name as authority. Such a broad assertion I have nowhere made, nor could I with truth on my side. I had received no information respecting the *quantity* found.

But it may be asked, "whence came the specimen, affirmed to have been brought from Charlotte?" It came, without doubt, from that place, but that was not, I think, the place of its origin. It was brought, originally, I am fully convinced, from the New York side of Lake Champlain, from the township of Willsborough, which is nearly opposite to Charlotte. "But that immense vein is not Coccolite;" nor was the specimen in question. It was colophonite. I have myself taken hundreds of specimens from the vein, precisely like the one transmitted to Prof. C.

This is the simple history of the error. I hope it will now be obliterated from the works in which it is published, and no more be copied.

Coccolite—red, brown and black—is very abundant, near Rogers' Rock, two or three miles south from the upper Falls in Ticonderoga, N. Y. This is the only locality, with which I am personally acquainted, where the mineral is found to be abundant. "Aluminous slate," Rockingham, Vt. "in argillaceous slate, which is quarried at horse-heaven." There has never been any argillaceous slate quarried, at the place called horse-heaven. A very limited quantity has been quarried, for grave stones, and perhaps, for other uses, half a mile or more, *below* horse-heaven.

"Hornstone" Cornwall Con. "on the late Judge Matthews' farm." Here is an error, committed by the compiler. The locality exists in Cornwall, *Vt.* but not in Cornwall, in Conn.

"Hornstone, Bridgeport," Con. "Hall." This should be *Bridport*, Vt.

There are many other errors of a similar nature, which I have not time at present to look up. F. Hall.

7. *Aurora Borealis—Magnetic Needle, &c.*—Communicated by L. D. Gale.—I noted in my private journal, some remarkable phenomena of the Aurora Borealis, during the 28th, 29th, and 31st of August, 1827, which I intended at that time to communicate for your Journal; but thinking that others more capable than myself, would better describe the same, I neglected to communicate my observations. Seeing, however, no observations on the magnetic needle, in the numerous notices in your Journal, except that of M. Arago, who states, that "The Aurora Borealis announced itself as early as 8 P. M. Tuesday 25th, by a very perceptible disturbance of the horizontal needle's diurnal variations." But the phenomena observed by M. Arago, could not have been the same observed in America, and described in your Journal, unless there was a mistake in the date: because August 25th came on Saturday, whereas, the 25th of September came on Tuesday, which latter must have been the time referred to by M. Arago, as a brilliant aurora was seen in this city the same evening, which even obscured the light of the moon.

When I first observed the luminous appearances of Tuesday, August 28th, at 10 P. M. I placed a horizontal needle, delicately mounted, in the window of my room, which was in the northern side of the house, and a dipping needle about ten feet distant in another window. On examination, I found that neither would come to a state of rest. The mean of the extremes in the horizontal needle, was at least 5° west of the magnetic meridian. After marking the extremes on a paper card, fixed in the window for the purpose, I left it. The dipping needle which oscillated from 64° to 75° was in constant agitation and very irregular in its motions; sometimes rising to nearly 60° and remaining for a moment with a tremulous motion, and then sinking back to 75° or 76°, having a mean dip of 69 1-2°, which is, I believe, according to the best needles I have seen, 2 1-2° above the true dip of this latitude.

The greatest variation of the needles was at 10 P. M. when I first placed them in the window, and it constantly decreased.

The brilliancy of the Aurora increased till 10 o'clock 30 minutes, when it gradually ascended towards the zenith, and at the same time diminished in brilliancy until 11 o'clock 30 minutes, when its luminousness had entirely disappeared: though there was a bright Aurora in the northern horizon.

On examining the horizontal needle, I found it constantly in a tremulous motion, though it did not oscillate more than 2 or perhaps somewhat less. The dipping needle was very quiet at 70°. On setting it to oscillating, however, a second time, it came to rest at 71°; the same was repeated with the same result, viz. 71°; whereas its ordinary dip is 72°.

The luminous appearances of the 29th and 31st, were less brilliant; and though I examined the needles to see if any effect was produced, nothing remarkable appeared during the Auroræ, except that the needles were seemingly a little longer than ordinary in coming to rest. *New York, April 21st*, 1828.

8. *Carpenter's Chemical Warehouse.*—We are pleased to announce, that Mr. Geo. W. Carpenter, who is advantageously known to our readers, by his papers on pharmaceutical subjects, has opened a Drug and Chemical Warehouse, at No. 301, Market street, Philadelphia. He has connected with his establishment, a laboratory for the manufacture of some of the most important articles, such as quinine, piperine, denarcotized opium, denarcotized laudanum, and acidulous tincture and extract of denarcotized opium, &c. &c.; and as these articles are manufactured by himself, or under his immediate superintendence, their quality may be depended upon.—Editor.

9. *Writ for the Medical Convention of* 1830.—Inserted by request of Dr. Mitchill.—Whereas the Convention that was held at the city of Washington, in the month of January, 1820, for forming a Pharmacopœia for our United States of America, did resolve that the President of that Convention should, on the 1st day of January, 1828, issue writs of election to the several incorporated State Medical Societies, in the northern, middle, southern and western districts of the nation, requiring them to ballot for three delegates to a General Convention, to be held at Washington, on the 1st day of January, 1830, for the purpose of revising the American Pharmacopœia; and whereas the several Institutions, as aforesaid, are, by the same authority, requested to forward to the President, on or before the first day of April, 1829, the names of the three persons so chosen; with sundry other provisions contained in the historical introduction to the work, to which the reader is referred.

Now therefore, I, *Samuel L. Mitchill*, by virtue of the power vested in me, by the Convention of 1820, *do hereby give notice*, to all the incorporated Medical Societies, Colleges of Physicians and Surgeons, Medical Schools, and Faculties of Universities and Colleges, and all other authorized Bodies, that they choose proper persons to represent them in the General Convention to be held in January, 1830, for revising the Pharmacopœia.

Given under my Hand, this first day of January, 1828, at the City of New York. Samuel L. Mitchill, *President.*

THE

AMERICAN

JOURNAL OF SCIENCE, &c.

Art. I.—*A Description of the Mineralogy and Geology of a part of Nova Scotia; by* Charles T. Jackson *and* Francis Alger.

(Concluded from Vol. XV, p. 160.)

The fossils discovered in it are the tellenite, pectinite, and terebratulite, which are common throughout the bed. They are usually small although very distinct. Among those of less frequent occurrence are small lenticular shells, resembling the nummulite, as figured in Parkinson's Outlines of Oryctology, plate vi, fig. 5. Also several impressions of entrochi, which, instead of being in cylindrical columns as they ordinarily occur, are formed of trochital, or round joints, which are smaller at one extremity than the other, so that the entrochus itself assumes a conical form. See Park. Org. Rem. vol. ii, p. 164. These impressions are not confined to the ore alone, but may be seen, more or less, in almost every slate stone scattered through the adjoining fields. Should this ore be explored, it is probable that a greater variety of these entombed relics will be brought to light, and furnish the collector with many rare productions of the antediluvian world. This bed of ore does not again distinctly appear, until it shows itself on Nictau Mountain, in Annapolis county, being covered and hidden for the whole distance by the unbroken forest. Intermediate indications of it have, however, been discovered, and masses have been found in several places; as for instance on the Horton Mountains, which are a part of the connected range. Here we found specimens of it exhibiting similar impressions with the other, and rendering probable the supposition, that the ore continues for the whole distance, though perhaps intercepted by dykes which are at present undiscovered. At Nictau, the width of the bed at the surface is but six feet and a few inches, but it seems to increase rather than diminish, as the mining operations advance. Its direction is similar to that of the bed in the district of Pictou. On removing the stratum of ferruginous soil from above it, the surface of the bed is seen curiously intersected by seams, which cross it transversely or nearly at right angles with its direction;—they are sometimes open fissures, and at other times filled up with a substance resembling red ochre. These seams give the ore a tendency to separate into rhomboidal fragments, similar to those into which slate frequently breaks, and much facilitate the labor of raising it. The bed has been opened to the depth of eight or ten feet, and about two hundred tons of the ore boated down the Annapolis River, to the smelting furnace, situated on the southern shore of the Annapolis Basin. The characters of the ore, at this place, do not differ materially from those of the Pictou ore. It is of a slaty structure and fine granular texture. Its color is brownish red and its streak a faint brick red. Its average specific gravity is 4.20, consequently it contains a little more metal than the Pictou ore, the earthy ingredients being nearly the same. It has a slight metallic lustre, and is magnetic, sensibly disturbing the magnetic needle.

The marine impressions in this ore are, if possible, more numerous, than in that of Pictou; indeed, the whole bed seems to have been an immense deposit of marine shells, exhibiting every where their remains. The fossils, however, at this place belong exclusively to the genus Anoma, for we did not succeed in finding a single species like those before mentioned, belonging to different genera. The slate also, when in immediate contact with the bed forming its walls, exhibits the same impressions: sometimes one half of the fossil being moulded in the ore, and the other half in the contiguous slate, which is apparently blended with the ore, so that the substance of the bed, must have been introduced into the open fissure of the preexisting rock, before the latter had become completely consolidated, or when it was in a plastic state, otherwise we would ask, would they not lie simply in contact with each other, like applying two surfaces together, the contact of the one not affecting the substance of the other. Werner, on this point, supposing the rock to have been formed anterior to the ore, says that in places where this peculiarity occurs, the rock has had a strong attraction for the substance of the vein, introduced into the rent, and has become so intimately mixed with it, that they both appear to be one and the same substance. (See Werner on Veins, p. 90.) This theory, after all, presupposes the rock to have been in a soft state immediately before, or to have been rendered soft by the introduction of the present contents of the bed or vein, (for it applies to either,) freedom of motion, among the particles of substances, being always necessary to their intimate combination. We should, therefore, on these grounds, supported in the theory by the additional testimony of the fossil organic remains being precisely the same, both in the slate and in the ore, be inclined to consider them of nearly contemporaneous formation, their intimate union having perhaps, been effected by the heat of the neighboring trap rocks of subsequent origin; of whose evident calorific effects on this bed of ore, at another place, where they nearly approximate to each other, we shall speak more particularly in a succeeding page.

The ore is traceable, for about a mile and a half, towards the Nictau River, and an iron bar is in all places sufficient to reach the bed, by piercing the overlying soil. A small opening has been made into it on the estate of Mr. Heaton, where we were unable to examine it particularly.

On ascending the high land from the falls on Nictau River, we met with a rock of a granular structure, inclining to foliated, breaking with a dull, earthy fracture, and having a pale green, or greenish grey color. It contains imbedded crystals of felspar, and is evidently a dyke of indistinct greenstone porphyry, as we have represented it on the map, intercepting the strata of slate, and perhaps cutting off the ore bed also. Were not this the case, the ore would show itself in the bed of the river, which it would necessarily cross, unless obstructed by some intervening barrier, as the direction of the two is nearly at right angles. On examining the river however, either side of which for several miles above the falls, presents naked strata of the slate extending to a considerable height, no traces of the ore could be discovered. It seems almost certain therefore, that the ore bed is interrupted by this dyke of porphyry, the direction of the latter being such as to cut it off, entering the north side of the hill: though owing to a small patch of the rock only, having been left naked by the passage of water over the face of the hill, the actual meeting of the two, or the place of their intersection could not be discovered. This will probably be met with ere long, by the miners in the progress of opening the bed, as it is found more advantageous to remove the ore to the depth of only a few feet from the surface, in consequence of which, they advance rapidly towards the dyke, or "whin" as they technically call such an obstruction.

In the vicinity of this dyke, we observed several irregular shaped masses of metalloidal diallage, which, when struck with a hammer were sonorous, ringing with a metallic sound, not unlike that produced on striking a solid mass of metals. Its color is green, tinged with grey, or is of a metallic grey. It is of an interwoven laminated texture, and breaks with difficulty, into fragments which are somewhat splintery, reflecting from the surfaces of the laminæ, the metallic lustre peculiar to this sub species.

One or two scattered masses of the variety of amygdaloid, called toadstone, were also noticed, possessing the characteristic appearance of this rock from Derbyshire, and resembling that found at Brighton in Massachusetts, which Godon, an accomplished French mineralogical traveller, first, recognised as this substance. From whence these boulders came, as well as those of distinct trap rocks which are extensively spread throughout the province, we are unable to say; as these rocks do not here occur *in situ*, and this is the only spot in the country, where the diallage and toadstone are presented in rolled masses. We may venture however to infer, that those of compact greenstone and vesicular amygdaloid were derived from the trap rocks of the North Mountains, and transported hither by that great and sudden catastrophe, which has almost every where left such incontestible proofs of its violence. But they not only afford us evidence of that violent catastrophe, but lead us further to believe, that the overwhelming torrent crossed this province from north east to south west, such being always the geographical situation of the fixed rocks, in relation to those of the same kind which have been severed from them, and carried forward to distant parts of the country. The boulders of granite, likewise afford proof of this fact;—they are never met with on the North Mountains, but are abundantly scattered over the face of the country in a south easterly direction. In like manner, are the water worn masses of trap rocks distributed; no débris of any kind being seen to the north west, which could possibly have originated from the south east.

In the fertile alluvion which forms the greater part of Aylesford township, and extends with the serpentine course of Annapolis River, into the basin of the same name, argillaceous iron ore, or bog ore, forms very extensive deposits. Two miles from Nictau, on the estate of Col. Eager, a stratum of it occurs nearly two feet thick, consisting of loosely united granular or globular concretions, known to furnacemen by the name of shot ore. It is sometimes of a spongy or vesicular appearance, and presents, to a great extent, the resinous lustre, which indicates a rich and profitable ore when seen in this species. It melts with facility, either by itself, or when employed as a fluxing material for other ores, yielding forty per cent of soft carbonated iron. In some places however, it is intermixed with the earthy phosphate of iron, the substance to which Bergman had attributed the cold-short quality of this metal in its malleable state, but which has since been proved inadequate to explain the phenomena, not only from the impossibility of an acid escaping decomposition in the intense heat of the smelting furnace and refinery, but also from the fact that ores containing no phosphoric acid, are equally liable to yield iron of a similar quality.

An attempt was made, in 1789, to manufacture bar iron with charcoal directly from this ore. A small bloomery forge, under the direction of a practical but unfortunate mechanic from the United States, was erected on the bank of Nictau river, a situation, which, combining almost every local advantage that could be wished, held out to those associated, a prospect of rich reward. But their anticipations were by no means realized, as unexpected circumstances proved the immatureness of the undertaking, and gave the project a new aspect, which blasted the hopes of those concerned, and rendered useless all that had been accomplished. A small quantity of iron had however been made and drawn into articles of husbandry. In this experiment, which, we should add, was the first actually made in the country with a view of manufacturing bar iron, the ore from Nictau was also attempted, but, requiring a different mode of treatment, it was found of no advantage and abandoned. The object of the proposed establishment on the shore of St. Mary's Bay, alluded to in the former part of our memoir, it will be recollected, was particularly the making of cast, or carbonated iron. This however, entirely failed. We have mentioned these facts for the benefit of those of our readers, who may wish to learn the early history of this branch of manufactures in Nova Scotia.

Leaving Nictau and the dyke of porphyry, the great bed of ore of the South Mountain, does not appear again, so far as the forest has been examined, until we reach the vicinity of Clement's, a distance of thirty miles. The evidence of its intermediate continuity is, however, such as to leave but little doubt on this point. For, in the bed of almost every brook or rivulet descending from the mountains, are to be found, to a greater or less extent, fragments of this ore, containing the usual marine impressions, and which at some time or another, must have been detached from the main body. Should the spirit of competition among iron manufacturers in this country, ever equal that which characterises some quarters of our own, we think that no part of this range would long remain unexplored, or fail to produce abundantly that article, on the working and application of which, every other art and manufacture essentially depends.

Before alluding, particularly, to the iron mine at Clement's, the description of which will comprise our concluding remarks on this valuable bed, we would advert to the patch of granite with black mica before mentioned, and which is represented on the map. This is the only rock in Nova Scotia having any claim to the title of primitive. It first appears along the South Mountains, a few miles east from Bridgetown, generally in large detached masses, which are piled in confined heaps on their sides, or have been precipitated into the valley beneath. Between Bridgetown and the village of Annapolis, it occurs in place, and forms for nearly the whole extent, the abrupt and barren mountains, which, having a rude outline, are contrasted with those composed entirely of slate, which present rounded and gently sloping sides. It also appears on the road from Annapolis to Clement's, in immense cubical blocks, which contain disseminated masses of chlorite and manganesian garnet. The latter is not distinctly crystallized, and being of a fragile nature, no interesting specimens can be obtained. These are the only imbedded minerals known to exist in it, as it does not contain metalliferous compounds of any kind.

The component ingredients of this rock are not united in very uniform proportions; the mica, of a brilliant jet black, enters largely into its composition. The felspar is sometimes of a flesh color, and the quartzy concretions are translucent and vitreous. The rock has a brecciated appearance, and includes masses of granite of a different nature from itself. These masses appear frequently in patches of a finer grain and darker color, than the surrounding granite, from which they differ only in this respect. The felspar of this granite is exceedingly prone to decay, and decomposes rapidly, on the exposed surface of the rock, insomuch that large quantities of angular fragments of the quartz are profusely scattered around, and constitute, by this débris, the first rudiments of the soil. The protruding angular fragments of quartz give this rock a rough, forbidding aspect—and becoming loose in a few weeks, they dislodge any lichens which may have clung to them for support, and thus preserve a barren surface defying all vegetation. The internal structure of this granite is firm and compact. It has a dark appearance, derived from the color of the mica, which is uniformly distributed through the mass. This rock would form an excellent building material, if the felspar was less prone to decomposition. This forbids its use in buildings, which are intended to last for a long time. We have before suggested, that this granite was subordinate or inferior to the clay slate of the South Mountains, and to all other rocks discovered in the province. It here exhibits itself, protruding through the clay slate. The line of junction was not however discovered as the covering of soil and underwood, concealed their union. That there does exist a point of contact near this place, we cannot doubt, for a person may in a few steps, pass from one formation to the other. The granite exhibits no appearance of stratification, from which we could estimate its direction, but there can be no doubt of its age being greater than that of the clay slate, which it evidently supports, throughout its whole extent. That the granite is older than the clay slate, appears from its containing no relics of organized beings which occur in the latter, and prove it to belong to the transition formation. We do not however consider this granite as belonging to the oldest primitive, from the absence of all those metalliferous compounds and minerals which characterize the more ancient formations—from its brecciated structure and perhaps from its containing only black mica, and being in contact with transition rock. It probably belongs to the third, or newest granite formation of Werner.

Speculative geologists may perhaps consider the relations of the bed of iron ore to this granite, as of some value, in accounting for the origin of veins and beds in transition rocks. They would doubtless regard the protrusion of the granite from the central regions of our globe, as the cause of the disruption of the strata of clay slate, which was thus raised from the bottom of the sea, bearing with it the spoils of the ocean. The layers would thus be broken, their edges thrown up at an angle, and by the contraction of the subordinate rocks, the superior strata being fixed, or the protrusion having carried the rocks so far as to poise the strata in a perpendicular position, a chasm would be formed, into which the ore of iron was afterwards poured from above by a second submersion. From the similarity of fossils, we should think the bed of iron ore, must have been immediately formed, after the disruption of the strata.

The granite might have been, nevertheless, much older than the clay slate, and constituted the base upon which it was deposited in a horizontal manner. The formation of rocks beneath the granite, by oxidation of the metallic bases, of the earths discovered by the illustrious Davy, according to the views of that excellent geognost, Daubeny, (if we do not misconceive them,) may have caused this protrusion of the granite against and through the overlying transition slate, which was thus raised from its horizontal position. The Wernerian and Huttonian theory thus united and modified, appear to account for so many facts in geology, we could not refrain from adverting to it on the present occasion, and suggesting its application to American geology.

The granite above described, is the only primitive rock which we discovered in Nova Scotia, but there can be no doubt of its existence in other districts of the South Mountain range, as we are credibly informed of its occurrence in the southern part of the province, which we did not visit, and which is left colorless on the geological map. This district remains unexplored and invites the attention of geologists.

Whether the great bed of iron ore following the clay slate comes in immediate contact with, or is cut off by the granite, we are unable to decide with certainty. From the direction of the bed at Nictau, we were led to suppose the latter to be the case. It is obvious, however, on reflection, that no argument can be drawn from this fact, there being an intervening distance of nearly twenty miles, and the mountains widening considerably as we approach the granite, their course at the same time, becoming so curved as to leave the highest land of the range, considerably to the southward of the line, represented on the map, as the southern boundary of this rock. Taking into consideration this fact, and the evidence derived from the direction of the ore bed at Clement's, we think it more probable, that the great bed is no where interrupted by granite, but that it continues in the more elevated parts of the range, which pass to the southward of the patch, shown on the map. The nature of this rock, therefore, and its relation to the slate, are, we think, so well established as not to require further notice.

We would here observe, that among the bowlders of the granite, are many scattered masses of sienite, of a very coarse, granular structure, and frequently containing large imbedded concretions of felspar, which on their surfaces decompose, and are converted into an earthy matter, like porcelain clay.

In the vicinity of Paradise River, a few miles from Bridgetown, gigantic crystals of smoky quartz, or the cairngorm stone of Scotland, are found among the masses of these rocks, or imbedded in the alluvion, which forms the banks of the Annapolis River. Of those most extraordinary for size, we would mention one found several years ago, on the estate of Mr. Longley, which, from his description, weighed more than one hundred and twenty pounds. We are indebted to him for several beautiful specimens of this mineral, some of which are nearly colorless and transparent, others of a smoky shade, passing into stone brown, and others of a faint yellow tinge. We have also in our possession, a magnificent crystal from this place, weighing ninety pounds. It is covered externally by a thin incrustation of common quartz, and presents within, the richest gradation of shades, from light topaz or straw yellow, through clove brown into a dark, and almost opaque smoky color. Clove brown is the predominating color, or characterizes the greater part of the crystal. It is rendered doubly interesting, by the long and slender prismatic crystals of black schorl, which traverse its surface, and even penetrate or shoot into its solid substance, to the depth of three or four inches. This crystal measures, in extreme length, nineteen inches. It is twelve inches in diameter at the base, and its six lateral planes are nine inches in length to the acuminating planes, one of which being unduly extended, nearly obscures the two adjoining ones, and is twelve inches in length.

Having thus far described the appearances and productions of the South Mountains, we shall now advert to the ore bed at Clement's, the last place along this range where it is known to appear. This bed is three miles from the mouth of Moose River, on which was erected, in 1826, an extensive establishment for smelting the ore, which has since gone into operation. Several extensive openings having been made into this bed, during the past season, from which many hundred tons of the ore have been removed, peculiar facilities are afforded for its examination. Its width considerably exceeds that of the Nictau bed, and perhaps ten feet may be assigned as its average; but from the intimate union of the ore with the contiguous slate, it is very difficult to discover the line of separation between the one and the other. In this respect it differs very materially from the ore of Nictau, where to a much greater extent, all the lateral limits of the ore are well marked, and the walls of the bed distinctly presented. By the assistance of a compass, this ore may be traced for the distance of two miles, towards Bear River, so powerful is its magnetic influence on the needle. Indeed, land surveyors are more or less perplexed by its influence, while traversing the forests, in different parts of this range. Their evidence, therefore, is in support of the continuity of this bed from New Glasgow to Clement's.

This ore is compact or fine granular, of a bluish grey or steel grey color, and possesses a glistening metallic lustre. When reduced to powder, its color is similar. It is highly magnetic, strongly affecting the magnetic needle, as we have before observed, and is in fact the magnetic oxide of iron, or exists in the state of the protoxide of this metal, combined with lime, alumina and silex. It resembles very much in appearance, the same species of ore from Franconia, New Hampshire. Its specific gravity, when examined in a homogeneous mass, is 4.5; consequently it exceeds that of either the Pictou or Nictau ore, and is considerably richer in the quantity of its contained metal; yielding by fusion in the assay furnace, sixty five per cent of soft cast iron. But in the large way, or when reduced in the smelting furnace, the per centage obtained, has hitherto been considerably less, owing to its admixture with the slate, from which it has been difficult to separate it. The pig iron obtained from this ore, is of good quality for strength and softness, and that of a harder nature, which contained less carbon, is readily converted into malleable iron, which is considered equal to the best of this description, made in the United States. The pure iron has also been converted into blistered steel, which on trial, was found equally useful, for all the purposes to which the foreign article had been applied. Should the flattering prospects continue, which now stimulate the exertions of the enterprising projectors of the establishment at Clement's, it is presumed that iron, in its various branches, will be extensively manufactured at this place, and thus supply the home consumption of the country.

The fossil remains contained in this ore, are by no means so numerous as in that of Nictau, and Pictou; but besides their impressions, we have other, and more interesting traces of them, which strongly indicate the effects of heat, upon the fleshy part of their substance, in decomposing and converting it into the substances, which are now presented in this ore. We shall allude to this more particularly, after stating the fossils which we recognized in the ore. They are terebratulites, tellenites and trilobites. Of the latter we obtained one, of which, only the body is presented, measuring two and a half inches in length. Its three lobes are very distinct and prominent, consisting of twelve transverse slips or lows, which gradually diminish to the lower extremity. The length of the first slip of the series being equal to that of the whole body of the fossil; its form instead of being as usual oblong and ovate, is conical.

In breaking masses of this ore, the fracture frequently crosses the fossil, and lays open its inner surface, which is covered by a very thin and brilliant bluish green, botryoidal crust of the phosphate of iron. It sometimes also presents this substance crystallized, in beautiful intersecting, and divergent plates or laminæ, which are translucent and of a deep blue or bluish green colour. In many cases, the cavity left in the ore by the decomposition or disappearance of the internal part of the fossil, is entirely filled up with a yellow, friable carbonate of iron, having intermixed with it a few bluish spots of the phosphate. At other times the crustaceous part of the fossil is converted into the carbonate of iron, which shows distinctly the original superficial appearance of the shelly covering. In fact, wherever in this ore, the remains of a fossil are found, we have one or both of these metallic salts, produced by the combination of its constituent principles, carbonic and phosphoric acids, with the surrounding iron, assisted as we have before ventured to say, by heat.

In addition to these, we have other arguments, derived from the phenomena presented by the ore, for ascribing the changes produced in it, to the calorific influence of a subsequent cause. It is well known, that iron is deposited from a watery or aqueous solution, only in the state of peroxide. Now the aqueous origin of this bed, is evinced by the presence of marine shells, to be met with in every part of it. And in accordance with the Wernerian theory, the space it now occupies, must once have been a deep open fissure, into which the ocean, when it overwhelmed the land, poured a part of its living contents; thus supposing the ore at Pictou, Nictau, and Clement's to have been formed at the same time, and by the same natural cause. How is it then, that the ore, as we now meet with it, assumes such totally different characters, in different parts of the same bed; that of Pictou being in the state of peroxide, as it was deposited from aqueous solution above, and that of Clement's, in the state of the magnetic or protoxide?—We conceive it undeniable, that this great change must be ascribed exclusively to the heat, attending the production of the trap rocks, of the North Mountains, rendering the ore at Clement's, in the immediate vicinity, strongly magnetic, by driving off a portion of its oxygen, while that at Pictou, more remotely situated, was not sensibly affected by its influence, but retains its full quantity of oxygen. Besides, according to this theory, we are enabled to account for the existence of so large a quantity, of carbonate of lime in the latter ore—the heat not having been sufficient to drive off the carbonic acid, from the fossil shells contained in it. The superior compactness of the former, its greater specific gravity, and more intimate union with the adjoining slate, from which, in most places, it is difficult to discover any line of separation, alike conduce to the confirmation of this theory.

We submit this theory, thus supported by facts, to the considerations of geologists, assured as we are, that should they trace the same ground, they would arrive at the same conclusion. If true, it proves at least the igneous origin of trap rocks in Nova Scotia; for on this supposition it entirely depends. It is therefore, we think, only by amalgamating the rival theories of Werner and Hutton, that just conclusions can be formed, of the geological nature of this country, and the relation which the rocks of aqueous deposition, bear to those of igneous origin.

The clay slate, forming the banks of Bear River, near its mouth, contains beds of iron pyrites, of a compact, amorphous character, well suited to the manufacture of copperas. In fact, where this mineral is freely exposed to air and moisture, the sulphate of iron forms spontaneously, and covers this rock with an efflorescent incrustation. The hepatic variety also occurs with it, and extending through the rock to some distance from the river, exhales in sultry weather, an odor, which cannot fail to apprize the inhabitants of its existence. This variety is converted by decomposition, into a brown, friable, oxide of iron, which in some places, forms a stratum more than a foot thick, and has lately been employed with advantage as a flux, in smelting the ore from Nictau and Clement's. No measures have as yet been resorted to for converting the pyrites into copperas, as an article of commerce, but we trust that the facilities here afforded for its manufacture, will ere long engage the attention of some enterprising inhabitant.

About four miles from Bear River, in the vicinity of a place called "the Joggins," the clay slate of the North Mountains, is intersected by another dike of porphyry, which is here presented, forming the sides of a deep recess or valley, but a few yards from the main road to Digby. It enters the strata nearly at the same angle with the dike, before mentioned, on Nictau Mountain; and like that, its actual connexion with the neighboring slate, being entirely hidden from observation, we were unable to determine its extent, or its more approximate relations to that rock. The base of this porphyry, is usually a greyish black trap, of a fine grained texture and compact. The imbedded granular concretions of felspar of a pure white color, are very numerous. Though for the most part, no regularity of forms is discernible in them. Sometimes, distinct parallelograms of white felspar may be observed. The rock is thus rendered more distinctly porphyritic than that of Nictau. Small concretions of brass yellow pyrites, are also disseminated through it. We would not attempt to discuss minutely the origin of the dikes which thus intersect, and entirely disconnect the strata of clay slate, for the same theory, applied to all other dikes of similar character, is equally applicable to these. They are probably, of posterior origin to the clay slate, and now occupy the immense fissures left by the contraction or solidification of the adjoining transition rock, including the great ore bed, and have proceeded from, or are coeval with the formation of the trap rocks of the neighboring North Mountains. Should the dike at this place extend for any considerable distance into the highland, it will also, be found most probably, to intersect the great ore bed ; which, from the direction of the latter near Bear River, must take place nearly two miles south of the valley. Whether the intersection does actually take place we are however unable to say ; as from the very imperfect examination, which has been made below Bear River, the ore has not yet been observed in place : but from the magnetic needle being affected in this quarter as sensibly as between Clement's and Nictau, this supposition is rendered extremely probable, if indeed, it is not confirmed by the discovery of masses of this ore, in different parts of the highland, near the shore of St. Mary's Bay, where the western extremity of the clay slate formation terminates.

The only rock which remains to be described belonging to the South Mountain range, is the quartz rock, represented on the geological map, accompanying this essay, alternating with the clay slate. This rock occupies but a small proportion of the country, and occurs principally in the township of Halifax, where it constitutes those dreary and barren hills surrounding that city, and which have been falsely considered fair specimens, of the soil of Nova Scotia. From the nature of this rock, this part of the country must for ages remain sterile, as this flinty aggregate obdurately resists the action of the elements, and will require a long period for the decomposition and disintegration of sufficient soil to reward the labors of the agriculturist, and from its nature, it never will advantageously compare with the rich loam of the valley of Annapolis, or the garden of Acadie, Cornwallis, which are more favored by nature in this respect. Halifax, fortunately, is not dependant upon her soil to " yield her bread," but, situated at the head of one of the most beautiful, and safe harbors in the world, with the romantic Bedford Basin in the rear, she possesses commercial advantages, to which those of no other place in the country can be compared, and is fully compensated for the imperfection of her soil, which, collected in the valleys, suffices to produce the garden vegetables for the city.

The quartz rock, to which we have attributed this barrenness of the soil, is composed, as its name indicates, of siliceous matter or quartz, which is sometimes fine granular, but more frequently compact. It sometimes is white, and the grains are transparent; but it generally has a greyish, or bluish tint, arising apparently, from an admixture with the neighboring clay slate, with which it is doubtless coeval. It frequently passes into flinty or siliceous slate, and is sometimes so intimately blended with the argillite, into which it passes, that the eye cannot distinguish, where the one begins, and the other terminates, so finely are their parts intermixed and combined. The layers of the siliceous slate, are always separated by a thin folium of argillaceous slate, while the quartz rock is exceedingly compact and possesses no stratified appearance. The latter contains less argillaceous matter in its composition. It breaks with a splintery and sometimes conchoidal fracture, and never separates into layers like the slate. This rock does not contain any minerals worthy of note; grains of pyrites, and a few crystals of quartz being the only minerals observed.

The quartz rock is represented on the map, as constituting strata of great dimensions. This is not strictly true to nature, for it alternates so frequently, as to render it impossible to give an exact view of its arrangement, but the proportion of this rock to the slate is correctly shewn by thus collecting the numerous narrow beds of this rock, into a few larger divisions.

One of these beds runs fifteen miles north of Halifax; two cross Bedford Basin, and the fourth forms a part of the Point, south of the city of Halifax, and the peninsula included between Margaret's Bay and Halifax harbour, where it presents itself to the ocean, and opposes an unyielding barrier against its mighty waves.

The traveller, proceeding from the United States to Halifax, who is desirous of examining the principal rock formations of Nova Scotia, described in this essay, can easily arrange his route, so as to examine the structure of the country. If he goes by the way of St. Johns, (N. B.) and takes the steamboat to Annapolis, he may examine to advantage, the greenstone trap rocks of the North Mountains, and the clay slate of the South Mountains, in his journey along the valley of the Annapolis River, in which he will travel between the two ranges to Windsor, and then traverse the country across the South Mountains, and the border of the sandstone formation to Halifax. We should, however, were it not for the convenience of the steam boat, prefer making our entrance beneath the lofty portals of Cape Split and Cape D'Or,—by taking passage from St. Johns to Windsor in one of the packets which statedly perform this voyage. Passing up the Basin of Mines, the tourist will behold some of the most sublime and beautiful scenery which this country affords, besides the most striking geological phenomena.

To describe the structure of this beautiful country in such a manner, as would be most useful to persons, who may succeed us in exploring the mineralogy and geology of Nova Scotia, has been the object of the present essay, which for the shortness of the time allotted to the examination of the country, can be regarded only as a rude sketch, exhibiting the more prominent features of its geological structure. Much yet remains to be discovered by future investigation, and we trust many of our countrymen, as well as of the inhabitants of Nova Scotia, will speedily fill up our imperfect outline, by an attentive examination of the strata which we have cursorily noticed. Some errors will probably be found in our statements, such as must unavoidably occur, in an account of the geology of an unexplored country, where there are but few of those conveniences which abound in our own, to facilitate the researches of the pioneer in its geology. They will we trust be found, in the main, correct, although some omissions will doubtless be discovered, and the boundaries of the rock formations, may not always have been exactly portrayed. This was a necessary consequence arising from the obscurity occasioned by the uniform covering of soil which exists in the interior, and, although it enriches the country in an agricultural point of view, it greatly embarrasses researches in its geology. The sea coast, denuded by the action of the waves, exhibits the most satisfactory views of its rock formations, and when defeated in our search for the outcroppings of strata in the interior, we scarcely ever failed in obtaining a view of them, somewhere along the extensive coast of this province. The simplicity and remarkable regularity in geological structure exhibited in Nova Scotia, cannot fail to excite the admiration of every geologist, who may examine that country, how much soever he may disagree with us, in our theoretical deductions.

In treating of the geology of this province, we have greatly exceeded the limits at first proposed, and have not only described the facts as they exist in nature, but have also pointed out the rationale of all the remarkable phenomena, as far as our knowledge extended, or our limits would permit. Theories which are generally known, and adopted, we have merely alluded to *en passant;* but where appearances justified it, we have advanced opinions, some of which are, perhaps, novel, although they were legitimate inferences from the facts discovered in our investigations, which were carefully made, and the results recorded on the spot where they were observed. Historical and geographical remarks, have been in a great measure excluded, being foreign to our purpose, excepting, when required to designate the localities and assist the traveller in finding those which were the subjects of our examination, and which furnished the facts constituting the basis of this memoir.

We are happy to learn that Thomas C. Haliburton, Esq. of Annapolis, a gentleman to whose politeness we are much indebted, has in the press an Historical and Statistical Description of Nova Scotia, from its earliest settlement to the present day. From the well known talents of this gentleman, whom, we believe to be the author of an instructive work, entitled "A General Description of Nova Scotia," published at Halifax in 1823, we anticipate in the forthcoming volume, a valuable, and highly interesting work which will do justice to this province, the history and productions of which are but little known abroad, or have generally been misrepresented. The frequent revolutions and change of masters that Nova Scotia has undergone, and the scenes of carnage which it has witnessed from christian, as well as savage warfare, furnish appropriate subjects to the muse and the novelist, as well as a fruitful field to the legitimate historian.

Art. II.—*Miscellaneous Notices of Mountain Scenery, and of Slides and Avalanches in the White and Green Mountains;* from a letter of the Editor—of the late Rev. Carlos Wilcox, and of Mr. Theron Baldwin.

The mountain scenery of this country, and the geological and other events connected with it, have as yet received little attention.

The following notices may supply some of these deficiencies, in the particular districts mentioned. The short memoranda by the Editor, are taken from a letter to his family, written during an excursion to the White Mountains of New Hampshire, in May, 1828; the letter of the late Rev. Mr. Wilcox, was published two years ago in the public journals, and has been recently embodied in a printed memoir of his life;* and the communication of Mr. Baldwin, was made at the request of the Editor, who was the more ready to ask it, because he had not seen any notice of slides in the mountains of Vermont.

1. *Extract from a letter of the Editor.*

Conway, (N. H.) at the mouth of the Gorge of the White Mountains, twenty seven miles from the Notch, May 18, 1828.

Our ride, of forty miles, from Concord to Centre Harbor, carried us through several flourishing manufacturing villages; among the rest, Meredith Bridge. We passed Friday, and Saturday forenoon at Lake Winipiseogee; on Friday afternoon we went two miles out upon the lake, but the wind being unfavorable, we returned. On Saturday morning, we ascended the Red Mountain, nearly two thousand feet high; the winding ascent occupies nearly two miles, and we were four hours on the excursion, but it richly repaid us. How much I wished you could have been there, and I thought that —— would have found grand subjects for her pencil. Imagine yourself on the very peak of this lofty granite mountain—naked and desolate, except here and there, a few mosses and stinted shrubs—its barren rocks, broken, water-worn, and decomposed by the tempests of ages—the splendid lake Winipiseogee, with its three or four hundred islands, sprinkled in a crystal expanse of twenty five miles long by eight broad—the Squam lake, and several other beautiful lakes, occupying also different points in the view—and a vast billowy ocean of high mountains, with their grand, intersecting curves, forming a complete panorama of the sublimest mountain scenery. I knew not how to leave it, and think that to a lover of grand scenery, and to an admirer of God's creative power, it is well worth a journey from New Haven. In the afternoon

* It appeared so valuable and graphic, as to be worthy of being preserved in this Journal, in connexion with the other papers.

of Saturday, we came on thirty miles, through noble alpine regions, and much pine forest, to this place, where we have passed the sabbath quietly at a comfortable inn, as the swelling of the Saco, which is between us and the place of worship, rendered it impossible to cross.

To-morrow we proceed, and expect to lodge the succeeding night at Crawford's, thirty five miles from this place, and beyond the Notch. It is the place whence travellers usually ascend the mountains.

At the younger Crawford's, White Mountain Post Office, thirty five miles from Conway, and west of the Notch in the Mountains, Monday, May 19, 9 P.M.

We are safe here, and have this day passed the grandest scenes that I have any where seen. The whole day's ride, in an open wagon, has been in the winding defile of mountains, which probably have not their equal in North America, until we reach the Rocky Mountains. The portion of the Notch which is the grandest, is about five or six miles in length; it is composed of a double barrier of mountains, rising very abruptly from both sides of the wild roaring river Saco, which frequently washes the feet of both barriers; and sometimes there is not room for a single carriage to pass between the stream and the mountains; but the road is cut into the mountain itself. Imagine this double barrier, rising on each side, to the height of nearly half a mile in perpendicular altitude, often exceeding this height, and capped here and there, by proud castellated turrets, standing high above the continued ridges; these are not straight, but are formed into numerous zigzag turns, which frequently cut off the view, and seem to imprison you in a vast, gloomy gulf. But the most remarkable fact remains to be stated.

The sides of the mountains are deeply furrowed and scarred, by the tremendous effects of the memorable deluge of August 28th, 1826. I will recal to your recollection, the awful catastrophe, which, on the night succeeding that day, destroyed, in a moment, the worthy Willey family, nine in number, and left not one to tell their painful story. For two seasons before, the mountains had been very dry, and on the morning of August 28th, it commenced raining very hard, with strong tempestuous wind; the storm lasted through that day and the succeeding night, and when it ceased, the road was found obstructed by innumerable avalanches of mountain ruins, which rendered it impossible to pass, except on foot. The first traveller who came to the Willey house, (which is very near where Mr. and Mrs. W. and party, ended their difficult journey, on horseback, nearly thirty years ago,) found it empty of its inhabitants, and in the course of a few days the mangled bodies of seven out of nine, were found about fifty or sixty rods from the house, buried beneath the drift wood and mountain ruins, on the bank of the Saco, or rather in the midst of what was for the time, a vast raging torrent, uniting one mountain barrier to the other. The effects of the torrents, which on that occasion descended from the mountains, now form a most conspicuous and interesting feature in the scenery.

May 20th, 9 P.M.

We have passed the day in the Notch of the Mountains, examining the scenery, the geology, and the ruins. The avalanches were very numerous; they were not, however, ruptures of the main foundation rock of the mountain, but *slides*, from very steep declivities; beginning, in many instances, at the very mountain top, and carrying down, in one promiscuous and frightful ruin, forests, and shrubs, and the earth which sustained them; stones and rocks innumerable, and many of great size, such as would fill each a common apartment: the slide took every thing with it, down to the solid mountain rock, and being produced by torrents of water, which appear to have *burst* like water spouts upon the mountains, after they had been thoroughly soaked with heavy rains, thus loosening all the materials that were not solid, and the trees pushed and wrung by fierce winds, acted as so many levers, and prepared every thing for the awful catastrophe. No tradition existed of any slide in former times, and such as are now observed to have formerly happened, had been completely veiled by forest growth and shrubs. At length, on the 28th of June, two months before the *fatal* avalanche, there was *one* not far from the Willey house, which so far alarmed the family, that they erected an encampment a little distance from their dwelling, intending it as a place of refuge. On the fatal night, it was impenetrably dark and frightfully tempestuous; the lonely family had retired to rest, in their humble dwelling, six miles from the nearest human creature. The avalanches descended in every part of the gulf, for a distance of two miles; and a very heavy one began on the mountain top, immediately above the house, and descended in a direct line towards it; the sweeping torrent, a river from the clouds, and a river full of trees, earth, stones, and rocks, rushed to the house and marvellously divided within six feet of it, and just behind it, and passed on either side, sweeping away the stable and horses, and completely encircling the dwelling, but leaving it untouched. At this time, probably towards midnight, (as the state of the beds and apparel, &c. shewed that they had retired to rest,) the family probably issued from their house, and were swept away by the torrent; five beautiful children, from twelve to two years of age, being of the number.

Search was, for two or three days, made in vain, for the bodies, when they were at length found, in consequence of the swarms of flies, which, it being hot weather, were hovering over the places. The bodies were evidently floated along, by the torrent and covered by the drift wood. A pole, with a board nailed across it, like a guide post, now indicates the spot, where the bodies were found, and we saw remnants of their apparel, still sticking among the splinters of the shattered trees. Had the family remained in the house they would have been entirely safe.* Even the little green in front and east of the house was undisturbed, and a flock of sheep, (a part of the possession of the family) remained on this small spot of ground, and were found there, the next morning in safety—although the torrent dividing just above the house, and forming a curve on both sides, had swept completely around them, and again united below, and covered the meadows and orchard with ruins, which remain

* Still, we cannot blame them for their sortie. They probably remained in their house, amidst the war of wind and rain and mountain torrents, and the tremendous crash of the forests—earth and rocks, which for miles around them, were rushing down in one wide scene of desolation, and with an astounding noise and concussion, of which, we can form no adequate conception; until the evident and near approach of the ruin immediately behind the house, and so near, that by the lights shining from the candles through the windows, they doubtless saw as well as heard it, left them, apparently, no alternative, but to fly from instant death. It was probably delayed but for a few moments, and they missed their only remaining chance, that of staying quietly with their animals on the little green, which escaped the deluge. But who could know that either that or the house would escape!—When, even now, almost two years after the event, we look at the frightful rampart of earth—stones—rocks and trees, which on one side is piled up within five feet of the house, and makes a circuit round it, as if *repelled* by an invisible power, it seems *almost* a miracle, and had the family remained in safety, we should have been half tempted to omit our qualifying word.

there to this hour. This catastrophe presents a very striking example of sudden diluvial action, and enables one to form some feeble conception of the universal effects of the vindictive deluge which once swept every mountain, and ravaged every plain and defile.—In the present instance, there was not one avalanche only, but many. The most extensive single one, was on the other side of the barrier which forms the northern boundary of the notch. It was described to us by Mr. Abbot of Conway, as having slid, in the whole, three miles—with an average breadth of a quarter of a mile; it overwhelmed a bridge, and filled a river course, turning the stream, and now presents an unparalleled mass of ruins. There are places on the declivities of the mountains in the notch, where acres of the steep sides were swept bare of their forests, and of every moveable thing, and the naked rock is now exposed to view.

In the greater number of intances however, the avalanches commenced almost at the mountain top, or high upon its slope. We pursued some of them to a considerable distance up the mountain, and two gentlemen of our party with much toil, followed one of them quite to the summit. The excavation commencing, generally, as soon as there was any thing moveable—in a trench of a few yards in depth, and of a few rods in width, descends down the mountains —widening and deepening—till it becomes a frightful chasm, like a vast irregular hollow cone, with its apex near the mountain top, and its basé at its foot, and there spreading out into a wide and deep mass of ruins, of transported earth, gravel stones, rocks and forest trees.

The road is now again cleared, and rendered practicable for strong wagons; but centuries may roll by, and the catastrophe of August 1826, will still remain recorded in characters that can neither be effaced, nor misunderstood.*

2. *Letter of the Rev. Carlos Wilcox.*

Hanover, (N. H.) Sept. 2, 1826.

I have just returned from an excursion to the White Mountains, and shall now spend a day of rest in this village, in

* The Willey house is again inhabited, and the family appear to feel no particular apprehension of a return of the calamity. It is again as before, a resting place for travellers, and although humble in its pretensions, is clean and decent, and the family are very civil and respectable.

giving you some account of the effects produced by the most destructive fall of rain ever known in that region. It happened on the night of the 28th of August, which will be long remembered in this part of the country.

I left Hanover on Saturday last, in company with two gentlemen of my acquaintance from the city of New-York, and rode as far as Haverhill, where we all spent the Sabbath. The road over which we passed was like a bed of ashes two or three inches deep; and the country around us exhibited the usual effects of a long drought. The abundant rains that fell three weeks ago, over the southern half of New-England, did not reach the upper part of the valley of Connecticut River. On Monday morning it began to rain at Haverhill, and continued along our route for most of the day, but so moderately and at such intervals, that with the help of great coats and umbrellas we proceeded on our journey in an open wagon as far as Bethlehem, fifteen miles west of the White Mountains. As we approached the vicinity of the mountains, the rain increased till it became a storm, and compelled us to stop about the middle of the afternoon.

The storm continued most of the night; but the next morning was clear and serene. The view from the hill of Bethlehem was extensive and delightful. In the eastern horizon, Mount Washington, with the neighboring peaks on the north and on the south, formed a grand outline far up in the blue sky. Two or three small fleecy clouds rested on its side, a little below its summit, while from behind this highest point of land in the United States east of the Mississippi, the sun rolled up rejoicing in his strength and glory. We started off towards the object of our journey, with spirits greatly exhilerated by the beauty and grandeur of our prospect. As we hastened forward with our eyes fixed on the tops of the mountains before us, little did we think of the scene of destruction around their base, on which the sun was now for the first time beginning to shine. In about half an hour we entered Breton Woods, an unincorporated tract of land covered with primitive forest, extending on our road five miles to Rosebrook's Inn, and thence six miles to Crawford's, the establishment begun by Rosebrook's father, as described in the travels of Dr. Dwight. On entering this wilderness we were struck with its universal stillness. From every leaf in its immense masses of foliage the rain hung in large glittering drops; and the silver note of a single unseen and unknown bird was the only sound that we could hear. After we had proceeded a mile or two, the roaring of the Amonoosuck began to break in upon the stillness, and soon grew so loud as to excite our suprise. In consequence of coming to the river almost at right angles, and by a very narrow road, through trees and bushes very thick, we had no view of the water, till with a quick trot we had advanced upon the bridge too far to recede, when the sight that opened at once to the right and to the left, drew from all of us similar exclamations of astonishment and terror; and we hurried over the trembling fabric as fast as possible. After finding ourselves safe on the other side, we walked down to the brink; and, though familiar with mountain scenery, we all confessed that we had never seen a mountain torrent before. The water was as thick with earth as it could be, without being changed into mud. A man living near in a log hut showed us how high it was at day break. Though it had fallen six feet, he assured us that it was still ten feet, above its ordinary level. To this add its ordinary depth of three or four feet, and here at day break was a body of water twenty feet deep, and sixty feet wide, moving with the rapidity of a gale of wind, between steep banks covered with hemlocks and pines, and over a bed of large rocks, breaking its surface into billows like those of the ocean. After gazing a few moments on this sublime sight, we proceeded on our way, for the most part at some distance from the river, till we came to the farm of *Rosebrook*, lying on its banks. We found his fields covered with water, and sand, and flood wood. His fences and bridges were all swept away; and the road was so blocked up with logs, that we had to wait for the labors of men and oxen, before we could get to his house. Here we were told that the river was never before known to bring down any considerable quantity of earth, and were pointed to bare spots on the sides of the White Mountains, never seen till that morning. As our road, for the remaining six miles, lay quite near the river and crossed many small tributary streams, we employed a man to accompany us with an axe. We were frequently obliged to remove trees from the road, to fill excavations, to mend and make bridges, or contrive to get our horses and wagon, along separately. After toiling in this manner for half a day, we reached the end of our journey, not however without being obliged to leave our wagon half a mile behind. In many places in these six miles, the road and the whole adjacent woods, as it appeared from the marks on the trees, had been overflowed to the depth of ten feet. In one place the river, in consequence of some obstruction at a remarkable fall, had been twenty feet higher than it was when we passed. We stopped to view the fall, which Dr. Dwight calls "beautiful." He says of it—"The descent is from fifty to sixty feet, cut through a mass of stratified granite; the sides of which appear as if they had been laid by a mason in a variety of fantastical forms; betraying, however, by their rude and wild aspect, the masterly hand of nature." This description is sufficiently correct; but the beauty of the fall was now lost in its sublimity. You have only to imagine the whole body of the Amonoosuck, as it appeared at the bridge which we crossed, now compressed to half of its width, and sent downward at an angle of twenty or twenty five degrees between perpendicular walls of stone. On our arrival at Crawford's the appearance of his farm was like that of Rosebrook's, only much worse. Some of his sheep and cattle were lost; and eight hundred bushels of oats were destroyed. Here we found five gentlemen, who gave us an interesting account of their unsuccessful attempt to ascend Mount Washington the preceding day. They went to the "Camp" at the foot of the mountain on Sabbath evening, and lodged there with the intention of climbing the summit the next morning. But in the morning the mountains were enveloped in thick clouds; the rain began to fall, and increased till afternoon, when it came down in torrents. At five o'clock they proposed to spend another night at the camp, and let their guide return home for a fresh supply of provisions for the next day. But the impossibility of keeping a fire where every thing was so wet, and the advice of their guide, made them all conclude to return, though with great reluctance. No time was now to be lost, for they had seven miles to travel on foot, and six of them by a rugged path through a gloomy forest. They ran as fast as their circumstances would permit; but the dark evergreens around them, and the black clouds above, made it night before they had gone half the way. The rain poured down faster every moment; and the little streams, which they had stepped across the evening before, must now be crossed by wading, or by cutting down trees for bridges, to which they were obliged to cling for life. In this way they reached the bridge over the Amonoosuck near Crawford's, just in time to pass it before it was carried down the current. On Wednesday, the weather being clear and beautiful, and the waters having subsided, six gentlemen, with a guide, went to Mount Washington, and one accompanied Mr. Crawford to the "Notch," from which nothing had yet been heard. We met again at evening, and related to each other what we had seen. The party who went to the mountain were five hours in reaching the site of the camp, instead of three, the usual time. The path for nearly one-third of the distance was so much excavated, or covered with miry sand, or blocked up with flood wood, that they were obliged to grope their way through thickets almost impenetrable, where one generation of trees after another had risen and fallen, and were now lying across each other in every direction, and in various stages of decay. The camp itself had been wholly swept away; and the bed of the rivulet by which it had stood, was now more than ten rods wide, and with banks from ten to fifteen feet high. Four or five other brooks were passed, whose beds were enlarged some of them to twice the extent of this. In several, the water was now only three or four feet wide, while the bed of ten fifteen or twenty rods in width, was covered for miles with stones from two to five feet in diameter, that had been rolled down the mountains, and through the forests, by thousands, bearing every thing before them. Not a tree, nor the root of a tree remained in their path. Immense piles of hemlocks and other trees with their limbs and bark entirely bruised off, were lodged all the way on both sides, as they had been driven in among the standing and half standing trees on the banks. While the party were climbing the mountain, thirty "slides" were counted, some of which began near the line where the soil and vegetation terminate, and growing wider as they descended, were estimated to contain more than a hundred acres. These were all on the western side of the mountains. They were composed of the whole surface of the earth with all its growth of woods, and its loose rocks, to the depth of fifteen, twenty, and thirty feet. And wherever the slides of the two projecting mountains met forming a vast ravine, the depth was still greater.

Such was the report which the party from the mountains gave. The intelligence which Mr. Crawford, and the gentleman accompanying him, brought from the Notch, was of a more melancholy nature. The road, though a turnpike was in such a state, that they were obliged to walk to the Notch House, lately kept by Mr. Willey, a distance of six miles. All the bridges over the Amonoosuck, five in number, those over the Saco, and those over the tributary streams of both were gone. In some places the road was excavated to the depth of fifteen and twenty feet; and in others it was covered with earth, and rocks, and trees, to as great a height. In the Notch, and along the deep defile below it, for a mile and a half, to the Notch House, and as far as could be seen beyond it, no appearance of the road, except in one place for two or three rods, could be discovered. The steep sides of the mountain, first on one hand, then on the other, and then on both, had slid down into this narrow passage, and formed a continued mass from one end to the other, so that a turnpike will probably not be made through it again very soon, if ever. The Notch House was found uninjured; though the barn adjoining it by a shed, was crushed; and under its ruins were two dead horses. The house was entirely deserted; the beds were tumbled; their covering was turned down: and near them upon chairs and on the floor lay the wearing apparel of the several members of the family; while the money and the papers of Mr. Willey were lying in his open bar. From these circumstances it seemed almost certain, that the whole family were destroyed; and it soon became quite so, by the arrival of a brother of Mr. Crawford from his father's, six miles farther east. From him we learnt that the valley of the Saco for many miles, presented an uninterrupted scene of desolation. The two Crawfords were the nearest neighbors of Willey. Two days had now elapsed since the storm, and nothing had been heard of his family in either direction. There was no longer any room to doubt that they had been alarmed by the noise of the destruction around them, had sprung from their beds, and fled naked from the house, and in the utter darkness had been soon overtaken by the falling mountains and rushing torrents. The family which is said to have been amiable and respectable, consisted of nine persons, Mr. Willey and his wife and five young children of theirs, with a hired man and boy. After the fall of a single slide last June, they were more ready to take the alarm, though they did not consider their situation dangerous, as none had ever been known to fall there previous to this. Whether more rain fell now than had ever been known to fall before in the same length of time, at least since the sides of the mountains were covered with so heavy a growth of woods, or whether the slides were produced by the falling of such a quantity of rain so suddenly, after the earth had been rendered light and loose by the long drought, I am utterly unable to say. All I know is, that at the close of a rainy day, the clouds seemed all to come together over the White Mountains, and at midnight discharge their contents at once in a terrible burst of rain, which produced the effects that have now been described. Why these effects were produced now, and never before, is known only to Him, who can rend the heavens when he will, and come down, and cause the mountains to flow down at his presence.

Yours, &c. CARLOS WILCOX.

3. *Letter of Mr. Theron Baldwin.*

New Haven, August 14, 1828.

TO PROF. SILLIMAN.

Sir—The following notice, first issued at Montpelier, went the rounds of the papers in the course of the last summer.

Montpelier, (Vt.) July 10, 1827.

Avalanche.—A gentleman at Fayston, on whose veracity the most implicit reliance may be placed, has obligingly furnished us with the following account of an avalanche of earth, or slide of the mountain, in Lincoln, Addison county, on the 27th ult., occasioned by the late abundant and almost incessant rains.

On the 30th of June, I went, in company with sixteen of my neighbors, to visit the spot so singularly marked by Providence, which I am now about to describe. I found the slide to commence near the top of the mountain, between two large rocks which were stripped of earth, opening a passage of four rods wide, from which it proceeded in a south easterly direction, gradually widening for the distance of two hundred rods, to the south branch of Mill Brook in Fayston. In its course it swept every thing in its way; overturning trees by their roots, divesting them of roots, branches and bark, and often breaking them in short pieces. A number of rocks, judged to weigh from fifteen to twenty tons were moved some distance. From where it entered Mill Brook, its course was in a north easterly direction, two hundred and eighty rods, the natural course of the brook being very small; but the channel cut by this torrent is now from two to ten rods in width; and on either side are large quantities of flood wood piled up very high; and from fifteen to twenty rods of the lower part it is blocked up across the channel in every direction; some of the trees are standing on their tops, and generally stripped of roots, branches and bark, and broken into many pieces. The pile in some places is ten feet high. Much of the timber is apparently buried several feet in sand and mud. One large birch tree was broken off square, measuring three feet nine inches where it was broken. One black ash was literally pounded into a broom, whose brush is seven feet long. The whole distance of these ravages, is a mile and a half, and the quantity of land thus suddenly metamorphosed into a barren waste, is twenty five acres. The force of water must have been very great, at which, we cannot wonder, when we consider its probable depth. In some places, from appearances, it must have been thirty feet high. Some of the trees on the sides of the channel were barked thirty or forty feet high, and there was mud on them at that height. T. B.

When this statement appeared, finding it difficult to conceive how, in those circumstances, causes adequate to the production of such effects could be put into operation—I resolved, should opportunity offer, to *see for myself.* Such an one presented itself in the month of May last. Accordingly, on a fine morning in company with a single companion, I started from a place in Fayston, distant about seven miles from the slide, eager to behold this scene of desolation, and enjoy a ramble on the Green Mountains. Three or four of the last miles, lay through an entire forest, and our only guide was Mill Brook, which came dashing down through the wilderness. During our ascent we found a number of streams emptying into this, but the marks of the flood were so evident, that we had no difficulty in deciding which to follow. The indications continued to grow more distinct as we advanced—till, what for hours we had so eagerly looked for, broke upon our view; and we emerged from the forest into an astonishing scene of devastation. For a time, I could not credit my own eyes; and while standing in the midst of this desolation, found it almost impossible to bring my imagination up to the conception, that a physical force could be accumulated in that place sufficient to accomplish the wonders with which I was surrounded.

I would here remark, that the statements of "T. B." as to distances, &c. may be relied on as correct—for I was told, by one of the sixteen who visited the spot, (as above related,) that they had a chain with them which was used in making the measurements. I conversed with a number of individuals in the vicinity, all of whom appeared to be well acquainted with the facts and ready to communicate them. The slide happened in the forenoon. The report was heard at the distance of several miles, and by some was thought to be an earthquake—by others, a clap of thunder; although they could not account for its long continuance. I was told, that it produced a very perceptible jar, similar to that of a peal of thunder. Had not the mountain been enveloped in fog, perhaps some favored mortal might have witnessed from an adjacent eminence, the appalling spectacle of rocks, and woods, and waters, roaring and rushing in frightful confusion down this precipitous descent! Various conjectures were afloat with regard to it, but as the fog vanished from the mountain, the true cause of the thundering and jarring was displayed to the view of the inhabitants upon the distant hills! It is visible from some of the adjacent towns, and has the appearance of a field recently ploughed. Fortunately as it was a number of miles distant from any human abode, wild beasts alone, were exposed to its ravages. A similar occurrence took place a few years since upon the same peak, but on a much smaller scale.

In its whole course before reaching Mill Brook, it swept through a dense forest, mostly of hemlock and spruce, and took off the entire surface, and every thing which it contained. The ground appeared to be as free from roots as if it had been tilled for fifty years. We observed some trees so firmly rooted in the rocks, that they could not be drawn out, which were pounded off upon a level with the surface of the ground, as if they had been but slender reeds. At some distance above the stream the mass parted, and left a few rods square of timber standing—but soon united again—and rushing on in all its tremendous power, struck obliquely against the opposite bank of Mill Brook, with a concussion that must have shaken the everlasting hills. This bank rises very precipitously and forms the base of another peak, which towers to a great height. At this place we judged the width of the desolation to be twenty-five or thirty rods. As the frightful moving mass now struck against an immovable barrier, and its line of direction must be changed before it could follow the course of the stream; we should expect a greater accumulation of water &c., at this place, than at any other; and just below the point where this wreck of the mountain tumbled into Mill Brook, I should not think it exaggeration to say, that a perpendicular, raised from the bed of the stream as it now runs, to a line drawn across the channel, and connecting points on either side where logs, sticks, &c. lie in such a manner, as to show that they must have been washed there by the current, would equal one hundred feet in length. It is certainly *surprising*, how, even on a mountain as precipitous as this—such a mass starting with a width of only four rods, could acquire sufficient momentum to carry before it an entire forest, and rocks of an enormous size: but gravity created that resistless power, which could so many times change its direction and urge it down the stream, in defiance of all the obstacles that opposed its progress, and where the elevation was constantly lessening. The principal and immediate agent was water, otherwise, the mass would not have proceeded farther than where it struck Mill Brook—for it is easy to see that a mass composed merely of trees, and rocks, and sand, however enormous its bulk or tremendous its momentum, could not have gone much farther than the first two hundred rods. But how could the water accumulate on the sides of that precipitous mountain to the depth of thirty feet, (as stated by T. B.) which I should think a moderate statement? This question arose as I stood gazing in astonishment, and I was strongly inclined to pronounce it impossible, notwithstanding facts which undeniably proved the contrary, that were staring me in the face. But it will not appear incredible when we consider that the timber above Mill Brook was principally hemlock and spruce, the boughs of which, would be extremely well calculated to produce an obstruction of the flood. A dam might easily be formed of the logs, boughs, rocks and earth, which composed this mighty moving mass, and the upturning of thousands of trees with the soil adhering to their roots, would greatly aid in effecting the object. And this appears to have been its *modus operandi* throughout the whole course. The ground was desperately disputed, but whenever a check was given to its progress, the foaming torrent would accumulate behind, till it had gathered sufficient force to burst every barrier—and again the huge pile proceeded thundering down the mountain. The forest seems to have been prostrated with as much ease as if it had been but a field of grain. The mass evidently went down in the wildest confusion. The trees sometimes erect, or sweeping around their branchless trunks in "horrid circles," would level tremendous blows at those upon the banks of the stream—as appeared by the bark frequently taken off at a great height—now their tops and roots alternately projecting forward, and again lying across the current were shivered in an instant. They are left in considerable numbers throughout the whole course, some lying upon the banks, others in the channel, and wholly or in part buried in the sand and rocks. But the principal part of the timber swept from these twenty-five acres, lies piled in a confused heap, covering perhaps an acre of ground, and four hundred and eighty rods, (one and a half miles,) from the spot where the slide commenced! Here, having already spent much of its force, and the mountain growing less precipitous, it struck into a cluster of firmly rooted trees and was compelled to stop. At this place it presents a perpendicular wall of logs, &c. across the entire channel, in some places ten or fifteen feet high. The upper end of the pile is buried beneath the sand and stones, and the stream now runs over the top. Perhaps those very logs will be dug out in after times as fossil wood.

Every thing in this mass, bears the marks of the greatest violence. Almost every tree is as completely divested of its roots, branches, and bark, as could have been effected by man, with the proper instruments. They are pounded and splintered and broken into all imaginable shapes and lengths. We felt ourselves amply repaid for our labor. It is well worth the attention of the lovers of the marvellous, and especially of every one who has never witnessed such tremendous effects, accomplished by the agency of water. I shall never more doubt, that water is adequate to the production of any of those effects, which are generally ascribed to the deluge. But I must confess sir, that while attending your lectures upon this interesting subject, I always had a kind of incredulity with regard to this point, which went very far to weaken the force of conclusions fairly deduced from physical phenomena, of whose actual existence I could not entertain a doubt. And while standing upon that mountain, I realized the force of a remark which you have often made, that we can never be properly prepared to reason upon the phenomena of the deluge, till we have *taken the field*, and witnessed for ourselves, the effects of those convulsions which have devastated the surface of our planet. Yours respectfully,

THERON BALDWIN.

ART. III.—*Gases, Acids, and Salts, of recent origin and now forming, on and near the Erie Canal, in the State of New-York; also living Antediluvian Animals;* by A. EATON.

[Continued from Vol. IV. page 368.]

THE subjects embraced under these heads might be included under the geological strata from which they issue, or to which they are attached. But several of them are of doubtful origin; and in some cases their origin is hypothetical. In cases of the latter kind, I prefer giving the hypothesis under this general head, to referring them more definitely.

I shall describe and consider the following cases.

1. The *Nitrogen gas*, in Hoosick, near the east line of the state of New-York, in Rensselaer county.

2. The *Sulphuretted Hydrogen gas*, near the head of Otsquago creek, ten miles south of the Erie Canal, on the Mohawk; and the same gas one mile south of Niagara Falls, on the Canada side of the river; also in combination with the waters of Springport, and of Lake Sodom in Manlius.

3. The *Carburetted Hydrogen gas*, at Vernon, twenty miles west of Utica; at Gasport, six miles east of Lockport, on the Erie canal; and near Canandaigua.

4. *Carbonic Acid gas*, at Albany, and in Saratoga county.

5. *Sulphuric Acid*, in Byron, thirty-five miles west of Genessee river.

6. *Sulphate of Magnesia*, six miles north of Troy; also at Coeymans, south of Albany; and in small quantities, at Auburn, Genessee Falls, &c.

7. *Muriate of Lime*, found every where in the marly clay of this district.

8. *Sulphate of Iron*, near the head of Cayuga lake, in Byron, and in M'Comb's mountains, easterly from Ogdensburg.

9. *Sulphate of Alumine*, near the head of Cayuga lake; near New Lebanon Springs, and in M'Comb's mountains.

10. *Carbonate of Iron*, in springs five miles west of Albany, and along the sand plains west of Hudson river, and other places where bog-ore is found.

11. *Muriate of Soda*, on the Canal line from near Rome to Niagara river; also in the salt licks. Particularly considering the pseudomorphous crystals in lias and saliferous rocks, imitating crystals of muriate of soda.

12. *Calcareous tufa*, at Otsquago, and along the canal.
13. *Living amphibious animals*, in secondary rocks near Whitesborough, and in Lockport.
14. *Living moluscous animals*, in diluvial deposits.

1. Nitrogen Gas.

This gas issues continually, in a state of purity or nearly so, from the earth, on John Bradt's farm in Hoosick, just within the limits of Rensselaer county, in the state of New-York. Dr. L. C. Beck and myself first tested it on the 17th of August, in 1821. The underlying rock appears to be the sparry lime rock, from a consideration of the surrounding rock; but the detritus is here deep, and conceals the rock.

The gas probably issues from every part of a low hill, comprising four or five acres of ground. For where there is water, it becomes manifest by bubbling through it. It issues abundantly from the hill through three springs, from the clean gravelly bottoms of each. But it does not combine with the water in either of them. Probably the gas accompanies the water from a considerable depth; for the water of the springs is not increased by the greatest spring and fall freshets.

The detritus appears to be very deep; and both the water and the gas may proceed from the underlying sparry lime rock. This conjecture is strengthened by another fact. New Lebanon springs are situated directly upon the sparry lime rock; which rock is in full view, and contiguous with that of Hoosick springs. The public houses are built upon it, and the same gas issues from New Lebanon springs, but in smaller quantities. These springs are about twenty-five miles south of the Hoosick springs.

The hypothesis of Longchamps* might perhaps furnish a plausible theory for the production of nitrogen gas at Hoosick and New Lebanon. He maintains that "the oxygen and nitrogen of the air unite and form nitric acid when in contact with calcareous substances which are sufficiently porous, and under the influence of a due proportion of heat and moisture. As the sparry lime rock is often found porous and of a spongy texture, it may cause the supposed union of oxygen and nitrogen of the air, which comes in contact with it at a considerable depth under the detritus. Here the tem-

* His theory is disputed by Gay Lussac, and adopted by T. Graham.

perature of the water may be suitable for the operation. If nitric acid is produced in this manner, the following may be taken for the result, with some allowance for fractions.

Nitric acid consists of 35.1 of nitrogen to 100 of oxygen. Atmospheric air consists of 376.2 of nitrogen to 100 of oxygen. Therefore every 100 of oxygen consumed in the production of nitric acid from atmospheric air, would produce 341.8 of unmixed nitrogen gas. Consequently, about ten-elevenths of the nitrogen gas of the air thus decomposed would issue unmixed from the earth.

2. Sulphuretted Hydrogen Gas.

This gas is too common to require many remarks. In this district it is confined to soft aluminous rocks. It is produced in large quantities in the softest varieties of argillite and greywacke. These rocks contain very soft fine-grained iron pyrites. That this gas is produced by the decomposition of the pyrites and water, has been so often shown, that I shall confine my observations to a few particular localities.

It issues from a spring on the Otsquago creek, ten miles south of Fort Plain, on the Erie canal, forty-two miles west of Schenectady. It burns along the surface of the water with a bright red flame, by daylight. It issues from the water continually at the rate of a little more than a gallon a minute. The same gas issues, in about the same quantity, from a spring on the Canada side of Niagara river, about a mile south of the falls. I examined both of these burning springs, as they are generally called, with very particular care, in the summer of 1823.

As water absorbs this gas with avidity, many springs, rivulets, and small lakes, are highly charged with it; but from which more escapes in the state of gas. The most interesting water of this kind, which has fallen under my notice, is Lake Sodom, in a place nicknamed Satan's Kingdom. It is about twenty rods south of the Erie canal, two miles east of Manlius Center. The bottom is grass-green ferriferous slate; the sides white shell-marle, and the brim is black vegetable mould. The water is perfectly limpid. The whole appears to the eye to be a rich porcelain bowl, filled with limpid nectar; but to the taste it is the true Harrowgate water, and readily convinces the visitor of the fitness of the name.

There is another very interesting water of this kind at Spring Mills, on the east shore of Cayuga lake. It issues from the earth in quantities sufficient for turning a grist mill. The water is perfectly limpid, and notwithstanding the large quantity of water which continually issues from it, the taste and odour of sulphuretted hydrogen are very strong. When I visited this spring in August, 1823, the pond made by the spring supported an extensive growth of the *hippuris vulgaris*, and no other plants. The owner of the pond, however, supposed he had seen a few different plants in former years.

Numerous small springs, highly charged with sulphuretted hydrogen, issue from the soft pyritiferous variety of argillite in the vicinity of the river Hudson, between Fort Edward and the Highlands. The water of these springs is always perfectly limpid.

The limpid appearance of all sulphuretted water may be explained, by supposing all coloring matters, whether animal, vegetable, or mineral, which give any opacity to water, to depend on the oxides of metals. As sulphuretted hydrogen will precipitate these oxides, nothing is left to discolor the water.

3. Carburetted Hydrogen Gas.

This gas issues through crag, or a gravelly soil, at the north side of a hill on the farm of Stephen Williams, one mile west of Vernon village. It is about six miles south of the Erie canal, and forty rods north of the stage road; and seventeen miles west of Utica. About a gallon a minute issues through a spring of water; which I calculated, from several trials by the watch, on the 30th of July, 1823. I observed it issuing from several small masses of water along the foot of the same hill; which naturally induced a belief, that it issues from the earth in all parts of several acres of ground adjoining the chief spring. The underlying rocks are fields or patches of ferriferous rock, resting on the saliferous rock. It burns with a flame of a reddish-white color, and blue at the base.

Six and a half miles east of Lockport, carburetted hydrogen gas issues through the water of a basin in the south side of the Erie canal. This was never observed until the water was let into the canal. Even then no notice was taken of it, excepting that one of the engineers observed that a gas, like that near Niagara Falls, (which is sulphuretted hydrogen,) had appeared in the canal. On the 18th of May, 1826, in company with twenty-one Rensselaer students, (whom I took through the canal from Albany to Lake Erie, on a geological tour,) I tested this gas. I found it to resemble that of Vernon; but approached nearer to the character of the light carburetted hydrogen gas. A large proportion of the flame towards the base is blue. The quantity which issues through the basin at one place exceeds a gallon in a minute; but we did not make sufficient trials for perfect accuracy. From a consideration of the surrounding district, we believe the saliferous rock to be between twenty and thirty feet below the basin.

The building of a village had commenced here, without a name. I proposed to the students to offer a name. They did so, and it was readily accepted by the proprietors. On our return we found the bridge and public houses labelled, *Gasport*. It is now the established name.

Another locality of this gas is described by Dr. Hays of Canandaigua, in the New-York Medical and Philosophical Journal, as being of the same character, within six miles of that village. Its geological relations appear to be similar to those described.

It will be recollected that this gas issues from the saliferous rock, or from a stratum which overlies it, in all the cases described. On the Eastern Continent, the largest coal measures lie under the saliferous rock, which is sometimes six hundred feet thick, and generally gives off the same gas. These facts should induce the legislature of the state of New-York to cause extensive boring to be made at proper intervals from Vernon to the Niagara river at Lewiston.

4. Carbonic Acid Gas.

This gas is so common and so well known that it is unnecessary to mention it, in reference to its ordinary appearances. That it is heavier than atmospheric air, and sinks down into, and remains in dry wells, and dry caverns, is well known. But the immense quantities issuing from the earth in combination with water in Saratoga county, require particular investigation. Not being prepared with facts for doing justice to this subject, I will state a few geological observations connected with it.

The small quantity which is found in combination with the waters of Mr. Cullock's well in Albany, and the immense quantity in the waters of Saratoga county, are produced from argillite. In both cases the borings of Disbrow have proved the fact. The argillite of both places (which are forty miles apart) contains large quantities of fine granulated pyrites, and finely disseminated calcareous spar. It is a well known fact, hereafter to be treated at large, that this variety of pyrites produces sulphuric acid by the aid of water. Being in immediate contact with the spar, gypsum is produced, and carbonic acid is disengaged at considerable depths in the earth, and under great mechanical condensation. This condensation causes its combination with water in such large proportions; which principle is demonstrated daily at soda-water fountains. The other materials found in these waters are referable to similar, or analogous principles. When the water issues from the earth, the pressure which forces it up to the surface being taken off, it parts with that portion of the carbonic acid which is combined by the effect of pressure. The solution of carbonate of lime, which is caused by the carbonic acid, can no longer be continued; consequently it is deposited in the form of tufa. Such is the origin of what is called the High Rock at Saratoga.

5. Sulphuric Acid.

This acid is produced by the decomposition of water and sulphuret of iron, in numerous localities; but the quantities of uncombined acid are generally small. For it combines so readily with lime, magnesia, alumine, and oxide of iron, that it is immediately consumed in the production of salts. It exists however in considerable quantities combined with water in the ancient crater of Mount Idienne in Java. This has been recorded as a remarkable fact, and the only known locality. It is said to destroy all vegetables as far as the water flows. To this hitherto single case on record, I am able to add another.*

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* *Note.*—Prof. Eaton will pardon us for adding "The Rio de Vinegro, or vinegar river—mentioned by Humboldt, which flows from the extinct volcano of Puracè, near Popayan. The waters are fatal to fish, and the spray irritates the eyes of observers. In a litre of this water (2.113 pints,) there were found, sulphuric acid 16.68 grains, muriatic acid 2.84, alumine 3.7, lime 2.47, and traces of iron. The crater emitted sulphurous acid abundantly, and there was a deposit of very pure sulphur eighteen inches thick. A lake within the crater proves to be a saturated solution of sulphuretted hydrogen, from whose reaction with the sulphurous acid, it is probable the sulphur arose." This Jour. Vol. xiv. p. 79.

Sulphuric acid in large quantities is produced in a diluted and in a concentrated state in the town of Byron, Genessee county, thirty miles west of Genessee river, and ten miles south of the Erie canal. It is on the land of Benjamin Griswold, near the house of David Kilborn, three hundred feet east of the transit line, which is the east boundary of the Holland Purchase. It has been known in that vicinity by the name of the *sour spring* about seventeen years. As travellers may be induced to visit this remarkable place, the following directions may be useful. Go to Holley village, on the canal, twenty-five miles west of Rochester, and sixty-eight miles east of Buffalo on Lake Erie. At Holley, take the carriage road south to Byron hotel, a distance of twelve miles: the distance from the hotel is two and a half miles in a westerly direction.

The following description I copy from my manuscript journal of a geological tour on the Erie canal line, in company with a section of Rensselaer school students. We visited that place on the 3d of July, 1828.

Here is a hillock two hundred and thirty feet long and one hundred broad, elevated about five feet above the surrounding plain. The hillock resembles the longitudinal section of an egg, with the convex side uppermost. Its greatest extent is north and south. It consists of a kind of ash-colored analluvion, containing immense quantities of exceedingly minute grains of iron pyrites. It is mostly covered with a coat of charred vegetable matter, four or five inches thick, and black as common charcoal. The same charred coal extends some distance from the base of the hillock on all sides. It appears as if it had been recently burned over, though it is in a meadow where no fire had ever been, at least for several years. Its charred state is caused wholly by the action of the sulphuric acid. Several holes have been dug in the hill, which now contain turbid dilute sulphuric acid; also the depressions in meadow ground surrounding it. Should curiosity or interest induce the proprietor to dig a trench about it, or to make an artificial pond on one side, which might be occasionally drained and cleaned, a very interesting bath of dilute sulphuric acid might be constructed.

The strength of the acid increases in a drought. When I examined it, considerable rain had recently fallen, and the acid was very dilute in most places. It was strong in some places, and appeared to be perfectly concentrated and nearly dry in its combination with the charred vegetable coat. In this state it was diffused throughout the whole piece of ground, which presented the charred appearance, to the depth of twelve or fifteen inches; and in some places three or four feet. But it was every where the strongest at the surface.

We received unquestionable assurances that in the time of a wet spring season, the *Erithronium dens-canis* (adder tongue) and some other plants flowered on this hillock much earlier than in the adjoining grounds, and grew more luxuriantly; but that most vegetables withered away, and appeared as if scorched, as soon as the profusion of spring rains began to decline. Trees have grown here, however; for several stumps, from one to three feet in diameter, still stand upon the hill. The largest now standing is a *prunus virginiana*, (cabinet cherry.) A few feebly growing vegetables are still alive—among which are the *rubus villosus*, *rumex acetosella*, *phleum pratense*, one species of *polytichum*, and one of *aspidium*. Also one species of *conferva* floating on the surface of the dilute acid.

I do not intend to be understood, that these plants are particularly adapted to such a situation, or that sulphuric acid can be borne by them better than by any other plants. It is probable the acid favors their growth when it is very dilute, and first injures, and then kills and chars them, as it becomes stronger by solar evaporation.

Besides the sulphuric acid, the water holds in solution variable proportions of sulphate of iron, and a small proportion of sulphate of alumine. I undertook to make an analysis with a view to ascertain the proportions of acid and salts to an assumed measure of water. But I detected such variable proportions of each, that no satisfactory result could be obtained.

The strength of the acid combined with the vegetable matter, and several other circumstances enumerated, make this locality very interesting. But there is another, about one hundred rods west of Byron hotel, being two miles east of this, which, in one point of view, is still more remarkable. It is a spring which issues from the earth in quantities sufficient for turning a light grist mill. Such an immense sulphuric acid laboratory is here conducted by nature, that all the water which supplies this perennial stream is sufficiently acid to give the common test with violets and to coagulate milk. I heard several other sour springs mentioned, which I had not time to visit. This is to be expected; for the same variety of analluvion prevails over a considerable extent of territory. The towns of Wheatland and Chili, in Monroe county, and the towns of Bergen and Byron, in Genessee county, have a most excellent soil for the growth of wheat. It seems to consist mostly of disintegrated lias. There are numerous knowls, or hillocks, which contain insulated masses of gypsum, similar to that which is taken from the lias in Manlius, &c. The iron pyrites which pervades the soil throughout these and other adjoining towns, is the same soft granulated variety which is found in the soft pyritiferous slate of Lake Erie, Cayuga Lake, &c.

Here a question of some importance presents itself. Why is all the sulphuric acid, produced by the decomposition of iron pyrites in some localities, wholly combined with the iron, forming sulphate of iron; while free acid is left in other localities; and a surplus in others which combines with magnesia, alumine, &c.? Is the pyrites a per-sulphuret in the latter case, and a proto-sulphuret in the former? Or are the iron and sulphur more perfectly combined in the former case? In support of the latter suggestion, it should be observed, that it is almost impossible to produce sulphuretted hydrogen gas with native cubic crystals of iron pyrites; while we do it with so much facility with the artificial and also with the native granulated variety by the aid of heat.

Whether or not we can assign the cause, the fact is certain, that by the decomposition of that variety of iron pyrites, whose grains can scarcely be seen without the aid of a lens, sulphuric acid is produced in quantities sufficient for forming alum and epsom salts in numerous localities. It is very probable that carbonate of lime is decomposed by the same agency; thus furnishing the immense supply of carbonic acid in the Saratoga waters.

6. Sulphate of Magnesia.

It is a curious fact that sulphate of magnesia had never been announced as an American mineral until Dr. T. R. Beck and myself published an account of the Coeyman's locality, in Mr. Van Rensselaer's Albany County Survey of 1820. Now it would require several pages to enumerate the known localities adjoining the Erie canal line. The very strong epsom salt spring at Coeymans in Albany county, the efflorescence on the marly clay banks at the same place, and the extensive efflorescence of epsom salts in Lansingburgh, six miles north of this city, (Troy, N. Y.) have been described by Dr. Beck and myself in our Agricultural Surveys of Mr. Van Rensselaer's Manor. It is in a solid state, attached to several of the secondary rocks, in situations defended from rains by shelving layers; as on the lias along Flat creek, south of the Mohawk—in the east ledge near the head of Cayuga lake, for three or four miles, in connexion with sulphate of iron and a thin layer of coal—in Auburn, in the base of a hill on the east bank of Owasco creek—at Genessee Falls, &c. In every case we find iron pyrites and magnesia in the rock to which it is attached.

The two greatest localities hitherto observed in this district, are those of Coeymans and Lansingburgh, before referred to. In both cases the incrustations of the salt form on extensive banks of marly clay, when the season is dry; which incrustation is dissolved and washed away with the first rain. At the Lansingburgh locality, which is on Judge Hickock's farm, the bank is forty or fifty feet high, and about as many rods in length. It is often seen after a long drought with the whole face of the bank nearly covered with the salt. The marly clay constituting the bank and producing the salt, gives evidence of the presence of magnesia when tests are applied. But I have never ascertained the proportion of it, nor how it is combined. Iron pyrites is found in it in very minute grains, and in variable proportions.

7. Muriate of Lime.

This is another case of a common salt, omitted in systems of mineralogy. I have not been able to find any notice of this salt, as a mineral, in any English or French work; although it is certainly one of the most universal salts known. On this account Dr. Emmonds, at my request, inserted it in his Manual of Mineralogy, published at Albany, 1826.

After the most diligent examinations, and inquiries, I have not found a bed of marly clay which did not contain it. Soak in pure water fifty pounds of dry or damp marly clay, taken from near the lower side of a layer, let it settle, and the clear supernatant liquid will always exhibit evidence of the presence of this salt, when nitrate of silver and oxalate of ammonia are applied to separate portions. All wells sunk in marly clay furnish what is denominated *hard water*. This character is given by the muriate of lime in most cases throughout this district. In the summer of 1819 I examined most of the hard-water wells from Albany to Blenheim, and along the banks of the Hudson for more than one hundred miles; also along the Boston stage road to Connecticut river. In the years 1820 and 1821, Doctors T. R. and L. C. Beck and myself tested most of the hard waters of Albany and Rensselaer counties. In all these cases the wells were sunk into marly clay, and contained muriate of lime. I have since extended the same examinations from Boston to Lake Erie, and the result was the same. From these and other observations, I believe that this character, " containing muriate of lime," might be added to the definition of marly clay, (London clay of Conybeare.)

8. Sulphate of Iron.

Having shown that sulphuric acid is produced in great abundance by the decomposition of iron pyrites, it will follow, that the presence of iron in contact with that acid is all that is required for the production of sulphate of iron. It is well known that oxide of iron is almost universally diffused in very small quantities, throughout all the earthy strata. But such minute quantities of sulphate of iron are produced, and it being sufficiently soluble to be even washed away by mists and heavy dews, very little is found in any particular locality. In sheltered places, such as under shelving ledges on the east shore of Cayuga Lake, near Ithaca, in connexion with a thin layer of sulphurous coal, and in a similar situation near the east part of the Helderburg, twelve miles from Albany, it is often found in considerable quantities. I have a large specimen before me, taken from the gneiss rocks of M'Comb's mountains by Mr. Courtland Van Rensselaer. He saw several pounds in a kind of efflorescent state at the same place.

I shall not enumerate localities of this sort; inasmuch as it is in every district in small quantities.

9. Sulphate of Alumine.

This salt is always present, as far as I have examined, wherever sulphate of iron is found. Being produced like sulphate of iron, by the agency of iron pyrites, no additional circumstance is required but the presence of alumine. Hence a mixture of impure copperas and alum is to be found in numerous localities in every district. The largest quantity that I have examined, is about three miles north of New Lebanon Springs, under a shelving ledge of argillite, about eighty rods east of the road towards Williams College. Specimens have been selected at both these localities, which are almost pure sulphate of alumine.

I have seen small quantities in more than a dozen places in the lias and third greywacke, along the Erie canal.

10. Carbonate of Iron.

This salt is more common than has generally been supposed. Most of the superficial springs in the range of bagshot sand, from near the head of Lake Champlain to Coxackie, twenty-six miles below Albany, contain carbonate of iron. As bog iron ore is very abundant in this range of bagshot sand, and as the outer surface of most of the masses of this ore is a friable covering of the carbonate of iron, we can satisfactorily account for the presence of the salt in these springs. Dr. T. R. Beck and myself analysed a spring on the western state road, five miles from Albany, which contained nearly a saturated solution of it, in dry summer weather. We detected its presence in numerous other springs in the same range.

Perhaps such springs will be found most common in connexion with this stratum. I found similar springs and bog ore, though in smaller quantities, in the bagshot sand of the valley of Connecticut river, between Hartford and Northampton. Also in the same stratum near the Erie canal, twelve miles east of Genessee river. Though carbonate of iron is perpetually forming upon our stoves, and upon other iron ware, I have not detected it in any springs whose waters I could not trace to bagshot sand containing bog ore. I would not however be understood to pretend that my investigations furnish conclusive evidence.

11. Muriate of Soda.

The extensive localities of this salt are too well known to require description. It is found in a state of saturation, in the saliferous rock from Vernon, (fifteen miles west of Utica) extending into Canada, about thirty miles west of Queenston. It is found in the same rock, wherever it has been perforated to a considerable depth, in most of the western states; and between the Mississippi and the Rocky Mountains. It is found also mixed with muriate of lime, in numerous localities, called Deer-Licks, in situations which cannot have any connexion with the formation with which the great salt springs of this country, and the salt mines of Europe, are associated. It is thus found on the metalliferous limestone near Sackett's Harbor, and on argillite and first greywacke in Reusselaer county, or third greywacke in Green county; and in numerous other localities in various geological strata. But the spring waters which are used for the manufacture of table salt in this country, are confined to the well known red and grey saliferous rock, the variegated sandstone of Werner. No salt has been detected in this rock where it underlies the basaltic rock on the Hudson and Connecticut rivers.

In the first part of the Erie Canal Survey, I made some remarks upon the origin of the salt springs. The speculations upon this interesting subject have been numerous and ingenious, but not satisfactory. At least I may say, that after reading the various essays which have appeared on this subject, and after an attentive examination of the whole range of salt springs in the canal district for the last eight years, I have made no progress towards a satisfactory explanation. To aid those who may be inclined to pursue the inquiry, I will add a few important facts, which have not been presented to the public. The discoveries were first made by Dr. James Eights, Prof. F. Edgerton, and myself.

There are immense quantities of pseudomorphous crystals, imitating, most perfectly, crystals of muriate of soda, in the strata of saliferous rock, and the lias which is situated above it. The pseudomorphous crystals are found in the softest varieties of calcareous slate, and red and grey marle-slate. They appear to be mostly cast in the hopper-form moulds of crystals, as they are called by the manufacturers of salt. But they often appear to have formed around the outsides of the cubic crystals of common salt.

I will give a few directions for those who are curious to examine those remarkable productions. First make yourself familiar with the process of crystallizing common salt in the large way; which may be best effected by spending one day at Syracuse, on the canal, and carefully inspecting the works where salt is made by solar evaporation. The works where a little fire heat is added, to aid the solar process, are the most instructive. You will see a cubic crystal form first, and then the series commence. One series of these little cubes will be deposited after another, the last lies on the preceding, so that one half of each block lies upon the last, with one half projecting. These successive series continue until the hopper is formed. It may be called a hollow pyramid, with steps inside and out. I have often seen them thus formed artificially, from two to three inches in diameter. After the hopper is formed, and generally before its sides are built up to its final height, cubic blocks are deposited in the same order inside. And these hoppers within hoppers are deposited until the solid cube is finished.

After observing this process, go to Manlius Center, and examine the ledge immediately adjoining the south bank of the canal, fifty-two miles west of Utica. Here you may find thousands of the empty moulds of these hoppers. We got out several masses of the soft lias rock at this place, and cut them across so as to open and show the outside and inside impressions in perfection, which were four and five inches in diameter. That the rock was deposited while in a soft state, upon the solid crystals, and the salt was afterwards dissolved, leaving the space it occupied empty, seems not to admit of a doubt. But what changes have taken place which should produce solid crystals at one time, and dissolve them at another?

Numerous specimens may be found which present every imitative form of the crystals in their progress from the hopper-form to the solid crystal. But at this locality, we find more specimens which present the hollow, than the solid crystal. The examination should commence here in preference to any place we visited, because it affords such large and perfect specimens.

Lastly, compare these pseudomorphous crystals of several localities. They may be found every where in the bank of the Salina branch of the canal, where it is cut through the rock in the village of Salina. Also in the south rock bank of the canal, one and a half miles west of the village of Jordan, eighty-two miles west of Utica. We found none so large at any place as at Manlius. Perhaps the characters of the rocks may have an influence. At Manlius, as before observed, the rock is *lias;* but at the other localities it is the red and grey saliferous rock of the marle-slate variety.

In the first part of the canal reports, I mentioned, that acicular crystals of common salt shot out from a specimen of the lias rock, after it had lain in a cellar for several weeks. Since that time, specimens taken from a quarry of water limestone on the high ridge between Auburn and Weed's Basin produced the same crystals in the same way.

12. Calcareous Tufa, or Porous Carbonate of Lime.

This mineral seems to have been produced by a cause which operated before the deluge, and still continues to operate. The shell marle is adopted by most geologists as the dividing line between antediluvial and postdiluvial deposits. It is in layers, more or less regular, under and alternating with the shell marle, along the canal line throughout almost the whole extent of the great swamp west of Utica. Here it embraces numerous dry-land plants. If its position in relation to the shell marle is evidence of its antediluvial character, these plants are antediluvial, and would furnish valuable materials to aid M. Brongniart in preparing his *Antediluvial Botany*. But my doubts on this subject have prevented my sending specimens, agreeably to his request.

That calcareous tufa is sometimes postdiluvial, and that it resembles the antediluvial kind in all respects, cannot be questioned. About ten miles south of Fort Plain, on the canal, the tufa formation is now going on. I have before me specimens of moss which I collected at that place, with growing tops, while the bases of the stems are entire substitutions of tufa. Large logs are now part tufa, and a part decaying wood. Near this place is a cavernous deposit of tufa from ten to forty feet thick, and three or four hundred feet long. It is very difficult to determine whether this is antediluvial or postdiluvial. Another locality of great extent at Elliott's Mills, three miles south of the canal where it crosses Oak-Orchard creek, presents similar appearances, and is still forming. For more particular descriptions of these localities, see Canal Survey, Part 1.

13. Living Amphibious Animals.

The discovery of toads in secondary rocks is often announced in public journals. A very particular account was published in the newspapers, of one found at Lockport, while they were cutting the canal bed in the geodiferous lime rock. I collected all the facts in my power, and examined the rock from which it was taken. The evidence would have been sufficient to establish any ordinary fact. But there seemed to be so many ways for illiterate laborers to deceive themselves, that I took no further notice of the report. But I have since received an account of a large dark brown toad being found in a rock of millstone grit, near Whitesborough, which I cannot hesitate to believe.

The Hon. Theodore Sill, of Whitesborough, who is now a representative in the legislature of this state, employed two respectable masons, whom I well know to be entitled to the highest confidence, both for their veracity and good sense. They were Mr. Reuben Wilcox, who has resided thirty-eight years on his farm one mile south of the village of Whitesborough; and his son, Morris Wilcox, who is a native of that place, and resides on his farm near his father. I am thus particular, that the curious naturalist may consult them personally, and learn their characters from their neighbors. They gave the following account of this remarkable preservation.

While laying the cellar wall of Mr. Sill's house, they had occasion to split a large stone, from the quarry which I call the millstone grit. It was perfectly close-grained and compact. On opening it they discovered a black, or dark brown spherical mass, about three inches in diameter, in a cavity which it filled. On examining it particularly, they found it to be a toad, much larger than the common species, and of a darker color. It was perfectly stupid. It was laid upon a stone, and soon began to give signs of life. In a few hours it would hop moderately, on being disturbed. They saw it in the yard, moving about, moderately, for several days; but it was not watched by them any farther, and no one observed its farther movements. They laid one half of the stone in the wall, so that the cavity may still be seen.

The millstone grit, in which this toad was found, is the oldest of the secondary rocks. It must have been formed many centuries before the deluge. Was this toad more than four thousand years old? or was it from an egg introduced, through a minute and undiscovered cleavage, into this cavity or geode, made precisely to fit the size and form of a toad? I was particular in my inquiry, and learned from them that the whole stone was perfectly compact, without any open cleavage which would admit an egg. Besides, it is well known that the millstone grit is neither porous nor geodiferous. If this rock stratum was deposited upon the toad, it must have been in aqueous, not in igneous solution; and the toad must have been full grown at the time. Toads are often found in compact, hard, gravelly diluvial deposits, in situations which demonstrate that they must have lived from the time of the deluge. I think I am warranted in saying this without citing authorities, as it is a common occurrence. Then why may they not have lived a few centuries longer, if we admit them a life of at least three thousand years?

14. Living Molluscous Animals.

The diluvial deposits in the great diluvial trough through which the Erie canal is made, contain ridges of hard compact gravel. A remarkable ridge of this kind lies in an oblique direction across the canal, running southwesterly from the village of Rome, sixteen miles west of Utica. While cutting through this ridge, the workmen found several hundred of live molluscous animals. They were chiefly of the *Mya cariosa* and *Mya purpurea*—(Unio of Bruguieres and Barnes.) I have before me several of the shells from which the workmen took the animals, fried and ate them. Mr. Brainard, who now resides at the place and keeps a public house on the bank of the canal, was present at the time, and will give the curious a satisfactory account of it. I have received several of the shells, with satisfactory assurances that the animals were taken alive from the depth of forty-two feet in the same deposit and near the same place.

I need not be prolix in the enumeration of facts of this kind; as similar cases are frequently recorded. My object is to present a case where the deposit is decidedly diluvial; consequently these animals must have lain from the time of the deluge. For the earth in which they are found is too compact for them to be produced by a succession of generations. Therefore the lives of these animals are greatly prolonged by exclusion from air and light, or their natural age is more than three thousand years. At any rate, they prove the absurdity of Darwin's hypothesis—that all animals are perfected at every successive generation, and that man "probably began *his* career as a fish." For these fresh water clams of three thousand years old, precisely resemble the same species which now inhabit the fresh waters of that district.

Art. IV.—*Information concerning the digging, preparation, and use of Peat; from a Memoir of Ribaucourt, published by the Council of Mines.**

Peat and its various uses have long been known in France. Its chief employment, however, has been limited to the departments of Somme, Loire-inférieure, Pas de Calais, some cantons of the departments of Oise, Marne, Eure, Seine et Oise, Meurthe, Vosges, and to a few others. There are many parts of the Republic, where its utility is unknown; yet, there is scarcely a valley which does not contain this valuable combustible. It is sometimes found in the sandy plains, called *landes* and *bruyeres*, and indeed upon some mountains, and beneath some forests and cultivated grounds, where it might not be suspected. In the department of Loire-inférieure, ten thousand persons are employed in working the peat beds, and in the commerce thence arising.

How very advantageous might it not be, to supply the deficiency of wood, which for many years has been experienced, by a substance that can be procured in most places, in abundance and at little expense; which in most cases may be substituted for wood, and even in many instances, with advantage!

It is therefore important to direct the attention of our citizens towards a substance, the procuring of which would be the means of diminishing the consumption of wood; and if we join to this advantage, that of furnishing fuel at a cheaper rate than that of the former, which affords in its ashes a manure that is sought after wherever it is known, and also

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* Middletown, Con. Nov. 10, 1828.

Professor Silliman:

Dear Sir,

My friend, Elisha Norton, M. D. of New-London, who has attended to the subject of fuel more than any one of my acquaintance, lately furnished me with a very interesting French pamphlet upon the subject of Peat, from which I have made the following translation. It consists of an extract from the *Journal of the Mines*, published during the period of the French Republic, but the date of the year is effaced from the title page. Should you consider it as a matter of importance, to diffuse the information contained in it among the citizens of this State, where there is unquestionably an abundance of this valuable article, you will be so obliging as to insert the translation in the Journal of Science. Yours, &c.

THOMAS MINER.

both before and after calcination, a considerable quantity of different salts, we shall perceive the full value of this kind of combustible.

These considerations have determined the Council of Mines to present the following results of their investigations to the Republic.

1. *What is Peat?*

Peat is a collection of vegetable substances, converted into blackish, bituminous masses, more or less combustible, mingled with divers portions of earth, sand, or the rubbish of shells and other matters.

2. *What are its Properties?*

It burns with a flame, exhaling a thick and fetid smoke when it is first kindled; after all its oily and volatile parts are dissipated by combustion or carbonization, it then exhibits no further odour. It burns till it is perfectly incinerated, and yields more ashes than any other combustible; these ashes are very valuable in agriculture. We can extract from them more or less sulphate of potass, and often sulphate of alumine. Peat, and the coal of peat, (for it is capable of being charred,) may be put to the same uses as wood and charcoal, and may be even advantageously employed in a greater number of the arts.

In peat beds, we have found fallen trees, well preserved and impregnated with water; animal bodies well preserved also, whose skin appeared to have gone through a kind of process of tanning. Many other observations show that the water, which has penetrated peat beds, has antiseptic properties.

3. *What are the positions of Peat Beds, and how are they found in nature?*

Layers of peat are often found in places which are still covered with water; but it is more frequently discovered at the bottoms of basins of ancient lakes and ponds, in marshes covered with stagnant water, or in currents which are neither rapid nor tumultuous. We meet with peat at great heights, upon the flat places of table lands of mountains, and even upon their declivities, provided they are in a region which is humid. We also find it upon different elevations upon hills and plains, under alluvion formed by posterior deposits, and indeed upon the sea shore under the sand.

Peat beds are more or less compact or condensed; 1st, according to the nature of the vegetables, the fragments of which compose them, their trunks and stems being preserved entire, or broken into fragments; 2dly, according to the greater or less thickness of the layer which is deposited, the bottom of which is compact and condensed by its own weight when it is thick, and looser when the deposit is inconsiderable; 3dly, according as there is, or is not, a superincumbent stratum of alluvion over the mass of the peat.

Peat beds are sometimes mingled with sandy, clayey, and shelly deposits. Above peat beds, we usually find a bed of marle or chalky clay. In some districts, this marle is much used in agriculture.

Several beds of peat are sometimes placed one above the other, separated by deposits of sand, clay and earth.

The thickness of peat beds is very variable, from six inches, to twenty feet.

Peat beds are ordinarily parallel to the deposits in the bottom of valleys; and their direction is also that of the valley, unless it has been deranged, or the formation of the peat has been interrupted by a rapid stream passing through the valley, or by some other cause which has an influence over the water of the valley.

We find in the work of De Luc, entitled *A Letter upon Men and Mountains*, some interesting details upon the progressive accumulations of masses of peat, analogous to that of glaciers in certain mountains. We have met, under certain beds in the valley of the Somme, with ancient causeways, divers tools, and pieces of money.

It would appear certain that peat beds are renewed, at least in circumstances favorable to their formation. It is however decided, that this renovation is a very slow process.*

4. *What are the means for discovering the existence of Peat?*

We may expect a valley to contain peat, when its surface is extensive, smooth, and it contains stagnant waters, or those

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* It is probable that the peat beds of the United States, especially those which have been worked near the sea coast, are derived principally from a vegetable somewhat resembling moss; and they are said to be renewed and filled again within twenty or thirty years, a much shorter period than is taken to reproduce them in France.—*Trans.*

which run sluggishly, and in a serpentine direction, from one side of it to the other.

The nature of the plants growing in marshes and valleys, does not enable us to discover the existence of peat, where there is sufficient vegetable mould to make a good sward; for in this case, there is nourishment sufficient for various kinds of plants.

Most kinds of plants will not vegetate in peat; but where there is a moderate layer of good earth superimposed, a multitude of plants, especially legumes, will flourish remarkably well, without doubt because their roots are continually furnished with the necessary moisture from the vicinity of the peat. In general, trees do not flourish well after their roots have reached the moist peat; but for alders to grow, it is only necessary to have their stems above water.

No certain opinion can be formed of the existence of peat, from the nature or the vegetation of plants; its presence is better ascertained, when trees are found to decay after their roots have reached a certain depth.

A more certain sign is the trembling of the ground, when it is struck by the foot; as well as by its compressibility, and its weakness and depression, when it is loaded with a certain weight. When moles bring to the surface parcels of peat, it is a sign that it is not far distant. But, all these means are not sufficient to justify opening a pit, or to warrant much expense in preparing to work it; for, besides the presence of peat, we must know its extent, its thickness, and its qualities. These things are discovered only by *sounding*.

5. *Sounding or boring for Peat.*

The peat men use a particular kind of *sound* or spade, which is as simple as all their tools, resembling somewhat the transplanting trowel of the botanists and gardeners. It is a kind of large spoon, of which the bowl is eleven inches in length, with very sharp edges, and a point of steel which is turned into a wimble. It is furnished with a strait wooden handle of fifteen to eighteen feet in length, upon which divisions of eleven inches each, called *points*, are marked. Sometimes the sound, or rather the scoop or bowl part of it, is twenty-two inches, or two points, in length.

At first, a square hole of two or three feet in diameter is made with a common spade, so deep as to reach the peat. Two men then force the sound perpendicularly, one *point*, into the peat. It is now turned round, and withdrawn with as much peat as it can bring with it. The quality of this is examined, and by a little experience its value is easily ascertained by the sight.

The sound is again introduced, and another point is taken up. This process is pursued, either till the whole layer of peat is perforated, or it is found to extend to a sufficient depth, and to be of such a quality as to justify the further opening and working of the bed.

If the peat were always uniform in quality, it might be sufficient to make but few perforations, merely to ascertain the extent of the bed; but in the same valley there is sometimes found excellent peat, and at a very little distance a very inferior kind. Sometimes, the first points are good or bad, and the last which are drawn from the same opening are of an opposite quality. It is therefore proper in sounding, to bore at the distance of every three fathoms, to ascertain the general quality of the bed, when the peat appears to be uniform; but when its quality is unequal, search should be made at the distance of two fathoms, and even of one.

We would remark, that after one stratum has been perforated and examined, the succeeding layer of sand or marle may be bored through, and the sounding be continued, because several strata of peat are often found beneath such deposits.

6. *The different kinds of Peat.*

The colour, weight, mixture of the different fragments of plants, fresh water shells, and earth, are the things which constitute the principal differences between the several varieties of peat.

The different combinations of it depending upon the degree of bituminization, are sufficient to produce very many kinds of peat; but there are only three kinds of it which are noticed as articles of commerce; viz. 1st, *light* peat, 2dly, *medium** peat, and 3dly, *hard* peat.

1st. Light peat is of a brown colour mixed with white, porous, intermingled with a greater or less quantity of reeds, rushes, and other marshy plants; and fresh water shells are often found in it. It burns with activity, shoots out a con-

* Brown or soft.

siderable flame, and is soon consumed. But little smoke exhales, and whitish and very light ashes remain.*

2dly. Medium peat is blacker, less porous, and heavier than the light; and it contains but few reeds. Only some very small filaments are found in it; it has few or no shells. It kindles with more difficulty than the preceding, burns less lively at first, and has less flame. There is a thicker, more fetid, and more abundant smoke. It gives less heat, and is consumed more slowly, and leaves a heavy, yellow kind of ashes.

3dly. Hard peat is of a still more intense black than the medium, and heavier than the two others. It is kindled with more difficulty than the preceding, has less flame, but is more lively; it exhales abundant smoke, which is thick, black, and very fetid; furnishes a very penetrating heat, consumes slowly, and continues on fire a long time, leaving a very reddish kind of ashes. There is no vestige of shells; and scarcely are there the slightest traces of the filaments of plants.

We might describe several intermediate varieties; and between the first and the third, there are innumerable shades. These three kinds, however, are the only ones distinguished in commerce, all the others according to their analogy being confounded with them. But there are two other kinds, which, on account of their inferior quality, require some attention.

One of these is whitish, heavy, full of shells, mixed with an earth, and is called *earthy* peat. The other is clear brown, porous and light, full of holes, resembling rather a package of moss than peat, whence it is called *moss* peat. So little account is made of these two kinds, that they are never worked, unless they are removed for the sake of finding good peat. They are thrown aside with the rubbish, or better burned to make a cheap kind of ashes.

7. *The working of Peat Beds.*

When peat beds have been sounded, and their dimensions and qualities have been explored, the peat is to be removed, in order to render the manipulations which are necessary to fit it for commerce. These operations consist in dividing the masses, cutting them into small parallelopipedons, which

* It is believed that light peat is the variety that has been most used in the United States.—*Trans.*

are called *peats* or *turfs*, and freeing them by desiccation from the water with which they are penetrated.

In order to have sufficient time for desiccation, which can be done only in spring and summer, it is necessary to begin digging the peat in the latter part of March, or the fore part of April.*

8. *The process of digging or raising Peat.*

The digging is done by making an open trench, because low grounds do not admit of galleries, as in mines of pit coal. One of the greatest difficulties to overcome, indeed the only one in working peat beds, is to keep the trenches and excavation sufficiently dry; but we must even raise it from under water, when it is not otherwise accessible.

In order to work with success, it is important to avoid the embarrassment of water. For this purpose, we must commence with opening the trench at the lowest place, leaving behind a sufficient declivity for the water to run off; or when we are forced to it, make reservoirs to receive it. Dykes and dams would be requisite, if we begun at the highest place, which would occasion expense, and expose to accidents and the loss of labour. The most regular way, is to open a trench at the lower part of the valley, so that it may form a drain as we ascend. When all is removed which is convenient by the spade, the remainder is to be taken out by a hooked or curved shovel called a *drag*.† This is better than to let the peat which is under water remain behind, and be lost. A canal made in this manner may often answer to float boats for carrying off the peat; or it may serve to drain the marsh. This canal, by being filled with alluvion, and matters deposited by rains and storms, may itself become valuable land for agriculture.‡ When the first canal is exhausted of its peat, another is to be made, taking care to have it so far distant as not to receive the water of the former, by its oozing through the intervening ground.

This manner of working peat beds is common in Holland, where a deficiency of wood has long made it necessary to

* In the latter part of April or in May, in New-England.—*Trans.*

† On account of pulling or working it as the Americans do the hoe.—*Ib.*

‡ According to Dr. North, if the conversation with him is accurately recollected, the excavation will fill again with good peat within twenty or thirty years, unless the marsh is so completely drained as to change its character. This refers to the peat beds in the county of New-London.—*Ib.*

seek for fuel of this kind. But in the greater part of the valleys in which it is obtained in France, a method more convenient for small estates has been pursued, by making only partial openings. However, instead of improving the ground, this plan pierces it with holes, filling it with stagnant waters, which diffuse disease among the adjoining habitations, at the same time that considerable peat is left in the marsh. It is a great fault to notch and cut up ground so irregularly and promiscuously, that a great part of it is necessarily lost, by means of the masses which are left; and the communication of the waters which distil from one opening to another, renders the labour very difficult, and often causes the work to be abandoned.

It is hence indispensable, in working peat beds, to attend to their localities and levels, in order to have the ditches made in such a manner as to allow the water to run off with ease.

Sometimes the peat rests upon sand, or upon stones that are inclined, furrowed, or of a porous nature, and disposed to absorb the water. These circumstances are fortunate for clearing a peat marsh of its water, and it suffices to dig till this porous earth is found. By this means, a *draining well* is formed, sufficient to remove all the water from the peat bed. When the beds are near ponds or lakes, we can often drain them by temporarily lowering these great reservoirs.

One precaution is still necessary——To have so much ground, that there may be room to spread the peat, and dry it upon the spot. At Menncey, where the beds are dug seven *points* in depth, it is calculated that six acres of surface are necessary to spread the peat which is raised from one acre; that is, nearly as many points of surface as there are cubical points of peat removed.

It is evident, that the dryer the ground on which the peat is spread, the more the operation of desiccation will be accelerated.

9. *Details of the Process of working Peat Beds.*

When the arrangements are made for working a peat bed, some of the workmen who are called *deblayeurs* (clearers) at the lowest place, where a beginning is to be made, take off the sward, and the vegetable mould, with a common spade, from the surface of about nine feet square. This rubbish is removed five or six feet from the opening, in order to avoid its pressing the adjoining ground by its weight, and causing it to be crowded into the excavation.

After the peat bed has been uncovered to the extent of these nine feet, some other workmen, who are called *tireurs*, (drawers,) cut it the breadth of two spades, raising it and putting it out at one of the angles of the excavation. This quantity will make two pieces of nine or ten inches broad, and seventeen or eighteen long, which are called *chanteaux*, (cantles, junks,) each of which is equal to two *peats* or *turfs*. A break being made in the bed, each tireur continues to cut, one going to the right and the other to the left, by means of a shovel with a wing projecting at its side, at right angles with the blade. The shape of the individual peats or turfs, is made by cutting with this instrument. They are parallelopipedons, eleven or twelve inches long, and three inches in the other dimensions. The top of the spade, or rather of its blade, is called the *point*, a point as we have said being the length of eleven inches. The parallelopipedons contract and shrink, more or less, in drying.

The faces or sides of the opening are cut perpendicularly, and the adjoining peat does not fall in, on account of its adhesiveness. It is subject to depressions only from weight being laid upon it too near its edge, which we have already cautioned against.

The ditch, cut perpendicularly, is continued along on one side of the pit or opening in the bed, so that the peat to be raised is cut only on two sides by the winged shovel, and is easily detached from the mass by the effort of the workman. 1st, he sinks the shovel to its depth, which we have said is a point or eleven inches; 2dly, he starts it by the handle a little forward; 3dly, he inclines it a little from the side opposite to the wing; 4thly, he brings the shovel again perpendicular; and 5thly, he raises the peat. When peat is cut under water, more time and caution are necessary.*

The stoutest *tireur* cannot throw the peat out of a pit which is more than fifteen points in depth, so that when the pit is eighteen or twenty points, it is necessary first to throw

* Thus far, it has been the intention to translate every sentence, not always literally, but sometimes by paraphrase, in order to convey the true meaning. The details are now becoming so minute, that it is expedient to omit some passages, and to abridge others. In some instances, the ideas of the original are expressed entirely in the language of the translator, to avoid a tedious prolixity.—*Trans.*

the peat upon a scaffold, or a bank that has been left for the purpose, from which another workman can throw it out of the bed; or it may be hauled out by the drag; or it is raised in boxes or tubs which are hoisted by machinery.

A common sweep with a weight on the farther end, like a well sweep, is the ordinary apparatus which is employed for raising the peat or the water from the deep pits. In these cases, the peat is often broken into shapeless masses, and it is frequently brought into form again, by putting it into a mould similar to one for making brick, from which the peat is deposited in a place for drying.

In Holland, a box or a large tub without a bottom, is often forced down into the bed, in the manner of a curb in digging some wells, by means of which the external water is kept out, and the peat within the box is removed in the common way. Other means are used in different countries.

10. *Drying the Peat.*

After the peat is thrown out of the pit, another set of laborers, called *brouetteurs*, (porters,) who are frequently women and children, lay it upon wheel-barrows, and remove it for drying. Not more than fifteen pieces, or *peats*, as they are called, should be carried at a time, and great caution is necessary to keep them in proper shape, and not to break them.

The pieces of peat are spread or dried in different manners, though more generally in small parcels or piles of fifteen each, laid much in the same manner as bricks are piled, with spaces between them for drying. In the course of the season, every individual *peat* should be exposed to the sun, which requires them to be handled several times. When these small parcels have lain a sufficient time, the surface of each peat is hardened into a kind of rind. It is now time to overhaul the heaps, and lay them again. The hardest are put to the bottom, and the number of each heap is increased to twenty-one peats, so laid as to admit the air to circulate freely. After this process has been followed so long that the rind or outside of the peats has become thoroughly hardened, they are removed again to give them their last drying. It is sufficient to observe, that the pieces of peat are now repiled in different ways, crevices being left to admit the air, very much in the manner that unburned bricks are disposed of and dried before putting fire to the kilns.

The preceding processes are performed in the open air. The peat is now once more removed, and placed under covers of thatch, boards, or heaps of straw; and it is assorted and put into what are technically called *piles*, a pile being five hundred and two cubic feet, Paris measure. The peat is still tender, and requires much care in handling it, and in conveying it to market.

Peat burns best in chimneys that have a powerful current, which will carry off the smoke and smell, in the same manner as they do those of coal. But, it is in the several arts and manufactures, that peat is more peculiarly useful. It is employed in furnaces under boilers, in burning brick and lime, and in preparing plaster. The ashes are very valuable in agriculture, and command a high price.

Peat admits of being charred, when it loses its unpleasant odour, and it may then be used as a substitute for the various kinds of coal, in all the arts.*

Art. V.—*Chemical Instruments and Operations; by Prof.* Robert Hare, M. D.

Application of Nitric Oxide Gas in Eudiometry.

The property which this substance has of forming with oxygen, nitrous or hyponitrous acid, either of which is absorbed by water, has caused it to be used in eudiometrical operations; but owing to its liability to be absorbed in a small extent by water, and the variable proportions in which the above-mentioned compounds are liable to be formed, the results, thus obtained, have been deemed uncertain, and the directions for using nitric oxide, given by such eminent chemists as Dalton, Gay-Lussac, and Thomson, are at variance. Gay-Lussac gave an empirical formula, agreeably to which, one-fourth of the condensation produced by a mixture of equal parts of atmospheric air, and nitric oxide, is to be assumed as the atmospheric oxygen present.

As nitric oxide consists of a volume of nitrogen and a volume of oxygen uncondensed, to convert it into nitrous acid,

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* The pamphlet concludes with a letter of the Minister of the Interior, to the Prefects of the Departments, upon the *working of peat beds.* It contains nothing of importance, which is not to be found in the preceding memoir, and consequently it does not require translating.—*Trans.*

which consists of a volume of nitrogen, and two volumes of oxygen, would require one volume of oxygen. Of course, if nitrous acid be the product, one-third of the deficit produced, would be the quantity of atmospheric oxygen present. This would be too much to correspond with the formula of Gay-Lussac.

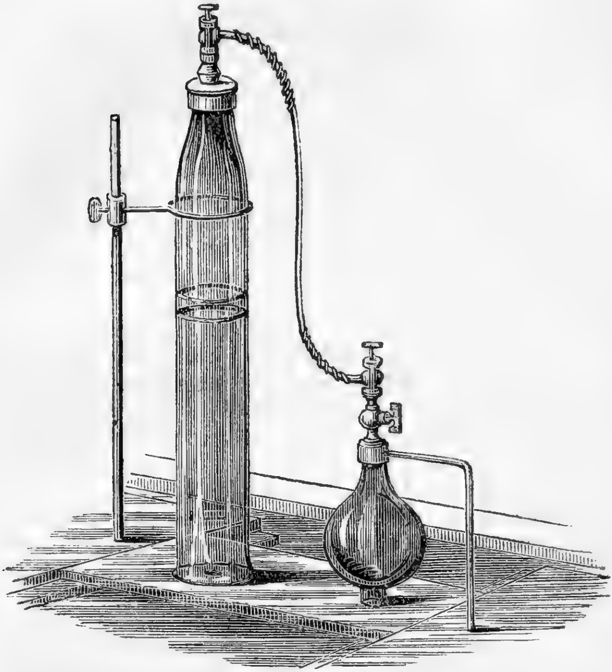
Supposing hyponitrous acid produced, only one-half as much oxygen would be required as is necessary to produce nitrous acid; so that instead of the two volumes of nitric oxide taking one volume, they would take only a half volume. The ratio of $\frac{1}{2}$ in $2\frac{1}{2}$, is the same as 1 in 5, or one-fifth, which is too little for Gay-Lussac's rule.

The formula recommended by Dr. Thomson, agreeably to which, one-third of the deficit is to be ascribed to oxygen gas, is perfectly consistent with the theory of volumes, and much more consonant to the results of my experiments than that recommended by the celebrated author of that admirable theory.

The late Professor Dana ingeniously reconciled Gay-Lussac's statement with the theory of volumes, by suggesting that a half volume of oxygen may take one volume of the nitric oxide, and another half volume of oxygen, two volumes.

	Vol.		Vol.	
	$\frac{1}{2}$ oxygen	takes	1	oxide and forms nitrous acid.
	$\frac{1}{2}$ oxygen		2	oxide and forms hyponitrous acid.
	—		—	
Deficit due to oxygen is as	1	to	3	

This result is evidently dependent upon the contingencies which may prevent nitrous acid from being the predominant product. I have accordingly found it precarious, in at least one hundred experiments accurately made with the sliding rod eudiometer.



New Eudiometrical process by means of Nitric Oxide.

Suppose a tube of about three inches in diameter, and two feet in height, closed at one end, to be marked by a diamond at the point to which it becomes charged, by receiving, when filled with water, over the hydro-pneumatic cistern, nine hundred measures of air, from the sliding rod gas measure, 127, also, at the point to which it becomes charged after receiving one thousand such measures. Into the tube thus prepared, while filled with water and inverted over the hydro-pneumatic cistern, introduce one thousand measures of air. Then add five hundred measures of nitric oxide, by means of a volumeter, holding exactly that quantity. After the red fume produced by this addition is washed away, by agitation with the water, there will be about eight hundred and fifty measures left. This will appear, upon adding from the sliding rod gas measure as many measures of hydrogen as are necessary to cause the residual air to extend to the mark for nine hundred measures. The whole quantity of the air and gas taken, being fifteen hundred measures, if only eight hundred and fifty are left, six hundred and fifty have disappeared, which, divided by 3, gives 216.6. It follows, that in 1000 measures of air, there are 216.66 measures of oxygen, and of course in 100 measures, 21.6.

The result corresponds more nearly with those obtained by the hydro-oxygen eudiometer, when, by means of a flexible leaden pipe, forming a communication between a volumeter and the top of the tube, we are enabled to introduce the nitric oxide over the air, instead of passing it up through the water.

The volumeter with which the pipe forms a communication, is, in shape, like the glass of the simple valve volumeter; but instead of being similarly accoutred, has only a brass cap and cock. To the latter, the pipe is attached. It should hold exactly five hundred measures of the sliding rod gas measure, in order to correspond with the marks upon the tube, made as above described.

Supposing that there is twenty-one per cent. of oxygen in the air, there would be two hundred and ten parts of oxygen in the one thousand measures taken, which would require four hundred and twenty measures of nitric oxide. Hence, it is probable that a volumeter holding a smaller quantity than five hundred measures, would answer for a thousand measures of air. The less nitric oxide there may be unnecessarily present, the less the risk of error, from its absorption.

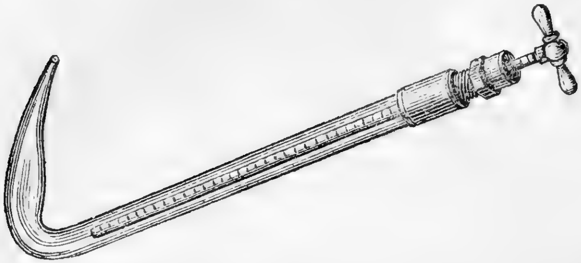
Sliding rod Eudiometer for Nitric Oxide.

Fig. 2, represents the form of the sliding rod eudiometer, which I have found most serviceable for experiments with nitric oxide gas, or those in which sulphate, or muriate of iron, saturated with nitric oxide, is employed.

The rod for these experiments, is graduated into one hundred and fifty large divisions, severally divided into five small ones, which, being each considered equal to two degrees, the whole number of degrees may be assumed either as one hundred and fifty or fifteen hundred.

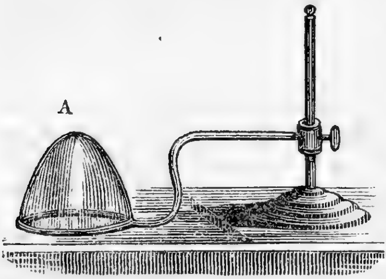
The mode in which the rod is made to measure gaseous fluids, has been explained.

FIG. 1.



The receiver, fig. 2, shaped like the small end of an egg, is employed in these experiments, being mounted so as to slide up and down upon a wire.

FIG. 2.



This receiver being filled with water, and immersed in the pneumatic cistern, the apex, A, being just even with the surface of the water, by drawing out the rod of the eudiometer, take into the tube one hundred measures of atmospheric air, and transfer it to the receiver. Next take fifty measures of nitric oxide from a bell as above described, and add it to the air in the receiver, without allowing the gas to have any contact with the water, which is not inevitable. Wash the mixture by a jet of water, which is easily produced from the apex of the instrument, and draw the whole of the residual gas into the tube, continuing to draw out the rod until one hundred and fifty graduations appear. In the next place, eject the residual gas from the instrument; the number of graduations of the rod which remain on the outside of the tube, shows the deficit produced by the absorption of the oxygen, and nitric oxide, in the state of nitrous acid.

In a great number of experiments, I have found the deficit to agree very nearly with that produced by the explosion of the same quantity of air with hydrogen in the aqueous sliding rod hydro-oxygen eudiometer.

METHOD OF ASCERTAINING THE PURITY OF NITRIC OXIDE.

Eudiometrical process by Nitric Oxide and Green Sulphate, or Muriate of Iron.

The purity of nitric oxide is easily ascertained, by means of a solution of green muriate, or green sulphate of iron, and the sliding rod eudiometer above described. A small bottle being filled with a solution of the salt, and inverted upon the shelf of the hydro-pneumatic cistern, take into the eudiometer one hundred measures of the gas and transfer them to the bottle, which must be agitated for two or three minutes. The receiver (fig. 2) being filled with water, and depressed into the water of the hydro-pneumatic cistern, till the apex, A, is on a level with the surface; throw up into it the residual gas. In the next place, draw it into the eudiometer. The distance which the rod is drawn out, shows the quantity, which may be again ascertained in ejecting it from the tube. A saturated solution of nitric oxide, in the above-mentioned ferruginous solutions, has the power of absorbing oxygen, and was consequently recommended by Sir H. Davy, as the means of ascertaining the quantity of that gas in the air. The mode of using them would be the same as that just described, taking atmospheric air into the eudiometer, instead of nitric oxide, and filling the bottle with the ferruginous solution of nitric oxide, instead of the pure sulphate, or muriate of iron.

I have found this method of ascertaining the quantity of oxygen, in the air, much more tedious, and much less satisfactory, than those already described.

1. DESCRIPTION OF AN IMPROVED MERCURIAL SLIDING ROD EUDIOMETER.

The aqueous sliding rod hydro-oxygen eudiometer,* although perfectly well qualified for experiments, in which water is employed, does not answer well when used over mercury. The great weight of this liquid causes the indications to vary, during manipulation, in consequence of changes of position too slight to be avoided.

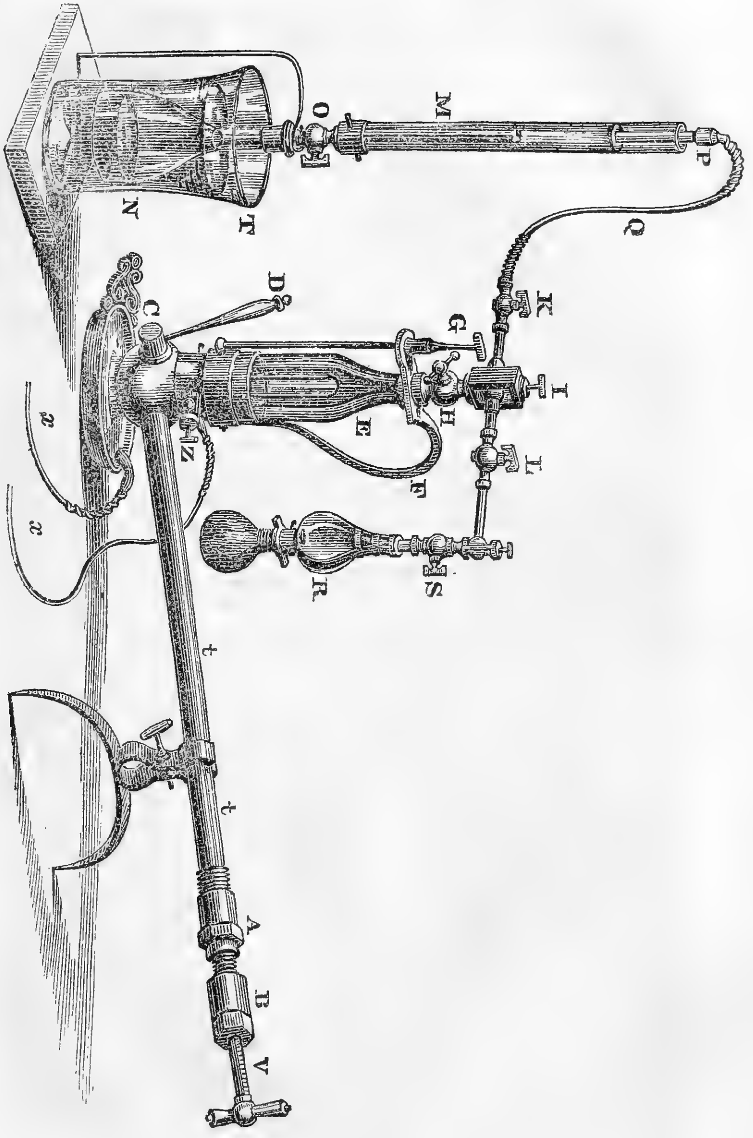
The instrument represented in the figure on the opposite page is furnished with a water gage, O M, which, being appealed to, enables us to cause the pressure of any contained

* See this Journal, vol. x. page 67.

gas to be in equilibrio with that of the external air, and consequently to measure it with accuracy. Excepting the gage, the mechanism by which the measurement is effected, is the same as that of the sliding rod eudiometers for water. However, in addition to the stuffing box at A, there is, in the mercurial eudiometers, a collar of cotton wick soaked in oil, and packed by a screw, B, which includes the cotton and compresses it about the rod. The object of this addition is to supply oil to the rod where it enters the collar of leather; otherwise, it would soon become so dry as to allow air or mercury to pass.

Let us suppose that this eudiometer has been thoroughly filled with mercury, and that it is firmly fixed in the position in which it is represented in the drawing, so that the lower part may descend about an inch below the surface of some mercury contained in an iron cup. At C is a cock, the key of which, in addition to the perforation usual in cocks, has another at right angles to, and terminating in the ordinary perforation. When the lever, D, attached to the key, is situated as it appears in the drawing, the tube containing the sliding rod communicates with the receiver, but not with the mercury in the cup. Supposing the lever moved through a quarter of a circle to the other side of the glass, the tube in which the rod slides will communicate at the same time with the receiver, E, and the mercury. F is a steel spring, which has a disk of oiled leather let into it, so as to correspond with the surface of the apex of the receiver, E, which is ground as true as possible. Hence, a slight pressure from the screw, G, renders the joint made between the apex of the receiver and the spring, air-tight; while at the same time the bore of the cock, H, communicates with the cavity of the receiver by means of a perforation through the leather and spring. On the other hand, the relaxation of the screw permitting the spring to rise, opens a communication between the cavity of the receiver, and the external air. The cock, H, supported by the spring, carries a gallows with a screw, I, which serves to fasten a small brass casting, so perforated and fitted as to produce a communication between the cock, H, and two others, K L, with which the ends of the casting are severally furnished. The cock, K, serves to open or close the communication with the gage, M, and bell glass within the jar, N. The bell glass is furnished with a cock, upon which the socket, O, of the gage, screws.

Fig. 1.



Description of the Water Gage.

The gage consists of three tubes, the interstices between which are partially supplied with water. In the first place a larger and outer glass tube, O M, open at the upper end, is at the lower end cemented into a socket attached to the cock, O, of the bell glass. Secondly, a small tube of varnished copper, the axis of which is made to coincide with that of the larger tube, is inserted into the bore of the cock. Lastly, a glass tube in size and situation intermediate between the tubes just mentioned, and open at the lower end, at the upper end enters the pipe, Q, which communicates with the bore of the cock, K, and of course when this is open, with the cavity of the receiver. When water is poured into the tube, M, if the pressure within and without be in equilibrio, it rises in the interstices between the three tubes to the same height; but whenever there is any diversity of pressure between the air of the inner and outer glass tubes, it is indicated by a consequent difference in the height of the liquid columns included.

Description of the Contrivance for the removal of Carbonic Acid, from the Gas left after exploding Gaseous Mixtures. partly consisting of the Compounds of Carbon.

The glass receptacle, R, fastens, by means of a gallows screw, to a knob at the end of a perforated cylindrical projection from the cock, L; so as, with the aid of interposed leather, to make an air-tight juncture. Between the gallows screw and the receptacle, another cock, S, is interposed, the bore of which communicates by means of corresponding perforations with that of the cock, L.

Below the receptacle a caoutchouc bag is fastened, which, as well as the receptacle, must be filled with lime water.

Means of causing the Explosion of Gaseous Mixtures, within the Receiver of the Sliding Rod Eudiometer.

A gaseous mixture, when contained in the sliding rod eudiometer, may be inflamed by galvanic ignition excited in a platina wire, in a mode analogous to that already described in the case of the barometer gage eudiometer.*

The circuit is established by means of the leaden rods, *x x*, one of which communicates with the mercury of the cistern,

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* See Art. 128, p. 127, of the Compendium.

while the other is fastened to the insulated wire by means of the gallows, *z*. To the rod which communicates with the mercury, a piece of iron should be soldered so that the lead need not be immersed, and consequently corroded. The insulated wire, where it enters the cavity of the eudiometer, is made air-tight by means of a small stuffing box. It is protected from the mercury within the receiver, by a covering of twine, well soaked in, and coated with shell lac varnish.

2. DETERMINATION OF THE QUANTITY OF CARBONIC OXIDE, IN A GASEOUS MIXTURE, WHEN NO OTHER INFLAMMABLE GAS IS PRESENT, BY THE IMPROVED MERCURIAL SLIDING ROD EUDIOMETER.

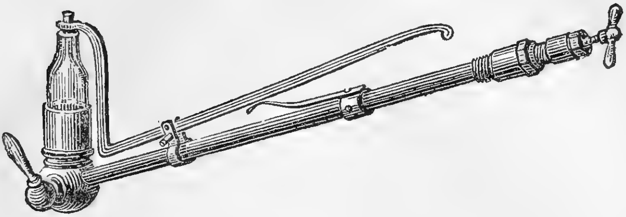
In the first place the mixture must be well washed with lime water, or a caustic alkaline solution, in order to remove carbonic acid, if present. In the next place let us imagine the bell glass, O N, after being adequately supplied over the pneumatic cistern with equal measures of the purified mixture and oxygen gas, has been transferred to the jar, I, containing a sufficiency of water to displace the gaseous mixture as required.

In order to fill the receiver with gas, through the gage tube and the pipe, Q, by which it communicates with the gaseous mixture in the bell glass, the eudiometer must be filled with mercury to the total exclusion of air, and the sliding rod wholly within its tube. Under these circumstances the spring being pressed upon the apex of the receiver by the screw, G, and the three cocks, H K O, being open; on drawing out the rod the receiver will be proportionally supplied from the bell glass with the gaseous mixture. The receiver being thus supplied, the cock, O, of the bell closed, and K, and H, being open, on pushing the rod home, the gaseous mixture driving the air before it through the interstices between the gage tubes, will in part effect its escape, in part supply in the tubes the place of the air which it has expelled. This process may be repeated two or three times. After the atmospheric air has, in this way, been removed from the apparatus, the cocks between the bell and receiver being open, if the rod be drawn out two hundred degrees, two hundred measures of the mixture, consisting of one hundred of each gas, will enter the eudiometer. This being effected, the cock of the bell must be closed. In consequence of the hydrostatic pressure to which the gas will have been subjected in the bell, its density, within the receiver, will be unduly great. Hence, the pressure of the screw on the spring must be relaxed until the gage indicate that the gas within the receiver has, by the escape of a portion of it, become with respect to pressure in equilibrio with the atmosphere. The cock communicating with the gage, is then to be closed, the pressure on the spring restored, and an explosion effected. The communication with the gage is now to be opened. The indicated deficit must be compensated, and measured, by pushing in the rod, until the columns of water in the interstices of the gage are on a level. In the next place, close the cock, K, communicating with the gage, and open the cocks, H L S, which are between the receiver and the receptacle, R. Into this receptacle, by forcing the rod home, the gas is to be transferred. Being agitated by the lime water, it is drawn back into the eudiometer, brought into equilibrio with the atmosphere, by appealing again to the gage, and then measured by noticing the number of graduations which the sliding rod must enter, in order to effect its expulsion. This residual air, and the deficit produced by the explosion being deducted from two hundred, the remainder will be the quantity of the carbonic acid, and of course of carbonic oxide originally in the mixture; since carbonic oxide, in passing to the state of carbonic acid, absorbs half of its bulk of oxygen without any enlargement of volume.

3. ANALYSIS OF OLEFIANT GAS.

As a volume of this gas has been ascertained to be equivalent to two volumes of carbon, and two volumes of hydrogen, it must require three volumes of pure oxygen for its complete combustion, and must leave, after the union, two volumes of carbonic acid. In order to insure a competent supply of oxygen, four volumes of it may be mixed with one of the olefiant gas in the bell glass, and the same manipulation resorted to, as in the case of carbonic oxide, excepting that before the explosion, the rod, V, must be drawn out to the greatest extent; and that as soon as the explosion has taken place, the rod must be returned into the tube, so as nearly to compensate the condensation, before resorting to the gage.

FIG. 2.—SUBSIDIARY EUDIOMETER.



4. OF THE USE OF THE SUBSIDIARY EUDIOMETER.

It may sometimes happen that the quantity of gas to be examined may be too small to be measured into the bell glass by a volumeter, as above described. In that case, a subsidiary eudiometer is employed. Excepting that it is shorter, the rod, in this instrument, has precisely the same dimensions as in that described in the preceding article; and the graduation, in both, is exactly the same. The use of the spring and lever, also the method of manipulation, may be learned from my memoirs, vol. x. page 67, of this Journal.*

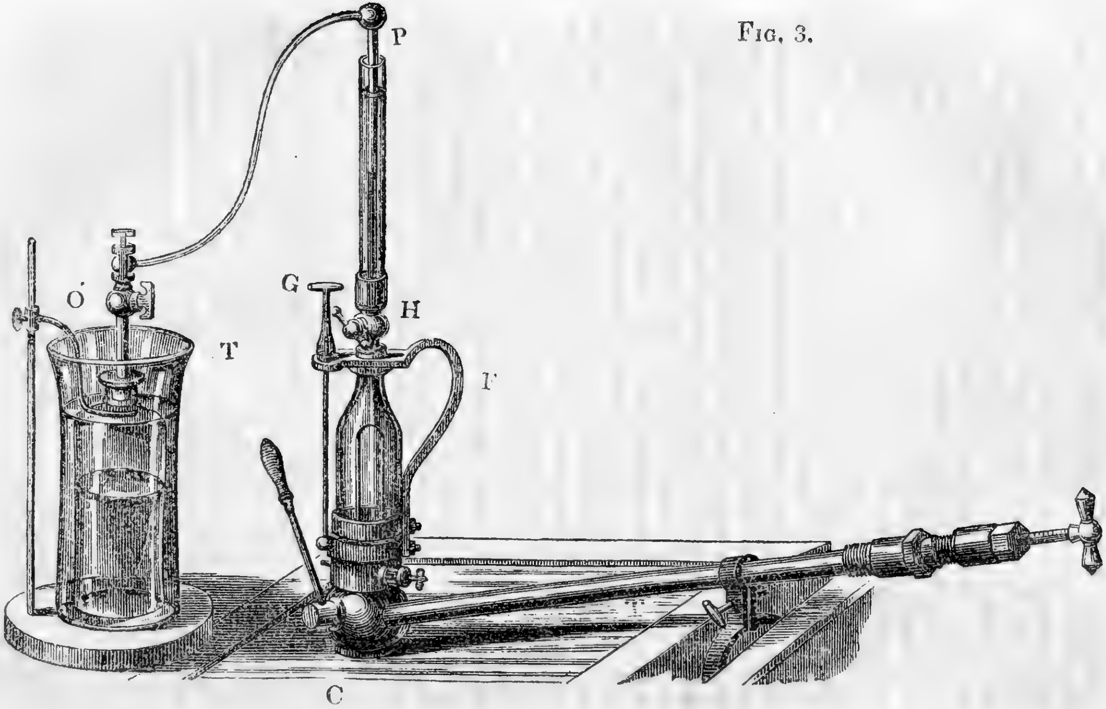
5. ANALYSIS OF CYANOGEN.

Let us suppose it were an object to ascertain the products which result from the combustion of a volume of cyanogen.

A quantity of oxygen gas amply sufficient for the intended experiments must be introduced into the bell glass, N, fig. 1, and two hundred measures drawn into the receiver of the principal eudiometer, the manipulation being the same as above described in the case of the mixture. In the next place, the subsidiary eudiometer must be supplied with one hundred measures of cyanogen, by introducing the apex into

* To prepare the instrument and prove it to be in order, depress the glass receiver below the surface of the mercury in the pneumatic cistern, the capillary orifice being uppermost, and open; draw the rod out of its tube, and return it alternately, so that at each stroke, a portion of mercury may pass in, and a portion of air may pass out. During this operation, the instrument should be occasionally held in such a posture, as, that all the air may rise into the glass recipient, without which its expulsion, by the action of the rod, is impracticable. Now close the orifice, (at the apex A,) and draw out a few inches of the rod, in order to see whether any air can enter at the junctures, or pass between the collar of leathers and the sliding rod. If the apex be held uppermost, any air which may enter will occupy a greater or less space near the orifice, so as to prevent the mercury from entering that space, when the rod is returned to its previous position.

Fig. 3.



a bell glass containing the gas over mercury, and duly drawing out the rod, the orifice of the receiver being kept open by pressing on the lever, only while above the surface of the mercury, and inside of the bell. The gas thus taken into the subsidiary instrument is next to be transferred to the principal one, *which must in this case be placed over the mercurial reservoir*, and be filled with mercury, the rod, V, being half withdrawn from its tube. By moving the lever, D, a communication must also be opened between the receiver, E, and the reservoir, and the apex of the subsidiary eudiometer must be introduced into a funnel-shaped cavity, with which the cock, C, is furnished. The rod of the subsidiary instrument being, under these circumstances, pushed home, the gas must pass from it into the funnel-shaped cavity, and thence rise into the receiver above it. When this object has been effected, close the communication with the reservoir, and open that with the iron tube, *t t;* also open the cock, H. Then appealing to the gage, adjust the rod so that the pressure of the included gas may be in equilibrio with that of the atmosphere. An explosion is now to be effected; after which, on opening the gage, if the cyanogen be pure, there will be no condensation.* The residual gas, by transfer to the receptacle, may be deprived of carbonic acid: and the deficit, thus arising, may be measured by transferring what remains to the receiver, and ascertaining how many measures the rod must enter, in order to eject it into the air, or to return it into the receptacle.

6. MODIFICATIONS OF THE EUDIOMETER, DESCRIBED IN THE PRECEDING ARTICLE.

The preceding figure represents another form of the sliding rod eudiometer, in which the apparatus for the removal of carbonic acid is omitted. The gage in this eudiometer is attached to the cock of the receiver, instead of surmounting the bell glass. It answers equally well in either situation.

If instead of the bell and jar, a self-regulating reservoir of hydrogen† were attached to the flexible pipe, a convenient

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* Before the explosion, two volumes of oxygen, and one of cyanogen, are present; the latter comprising two volumes of carbon, and one of nitrogen. During the inflammation, the carbon is transferred to the oxygen, without altering it in bulk, while the nitrogen is set at liberty, uncondensed, so as to occupy as much space as the cyanogen did previously.

† See this Journal, Vol. xi. page 140.

arrangement would be obtained for ascertaining the proportion of oxygen in the atmosphere. In that case, the mode of operating would be as follows. The pipe and tubes of the gage being filled with hydrogen, and the receiver with mercury, also the cocks, H and O, being open, draw out the sliding rod fifty degrees. A quantity of hydrogen, in bulk equivalent to the part of the rod withdrawn, will pass from the reservoir through the flexible pipe, into the cavity of the receiver. The cock, O, being shut, on appealing to the gage it will be found that the hydrogen, in consequence of the hydrostatic pressure of the reservoir, will be a little denser than if in equilibrio with the atmosphere. By relaxing the pressure of the screw, G, upon the spring, as much hydrogen will escape as may be necessary to produce an equilibrium. If while the cavity of the receiver is thus, in communication with the atmosphere, the cock, H, being shut, the sliding rod be drawn out 100 degrees further, so as to reach to 150 on the scale, 100 measures of air must enter. The pressure of the screw, G, upon the spring, F, being restored, and an explosion effected, agreeably to the directions already given, by returning the rod into its tube, more or less, and appealing to the gage, the deficit may be ascertained. If no error shall have taken place, expelling the residual gas will just return the rod to the situation, which it occupied when the experiment commenced. Of the deficit, of course, one-third is due to oxygen. It may be proper to mention that some delay is necessary, in order to permit the residual gas to part with the heat, acquired from the combustion of the hydrogen and oxygen.

As for the analysis just described, the eudiometer may, as represented in the preceding figure, be seated in a cup of mercury, instead of being placed over a mercurial reservoir; and since the apparatus, when once put into operation, enables us to multiply experiments with great facility; it will be found peculiarly well calculated for a series of observations, under circumstances in which access to a pneumatic cistern cannot be had.

7. *Eudiometrical Apparatus analogous to the preceding, excepting that it is constructed of Brass, used with Water, and that Explosions are caused in it by an Electric Spark.*

In the analysis of atmospheric air, agreeably to the process last described, no gaseous product being generated, which is absorbable by water, it is not necessary to employ mercury, and, consequently, to have the metallic part of the eudiometer of iron and steel. It is in fact preferable to have it of brass, as in that case it will not rust, and may be kept in operation for many months, without requiring much adjustment. I have an apparatus thus made, and so contrived as to be ignited by an electric spark. Excepting the substitution of brass for iron, there is no material difference between that apparatus and the one represented by the figure, excepting that the receiver, E, is exchanged for one of which there is an engraving in the Compendium.*

In the brass eudiometer last described, the cock, C, is omitted; while, at right angles to the receiver, a small cock is inserted, which supports a glass vessel holding water. By these means, any excess or deficiency of this liquid is easily remedied, and the employment of the cup, beneath the eudiometer, rendered unnecessary.

8. DESCRIPTION OF THE VOLUMESCOPE.

In the next page there is an engraving of an instrument which I have advantageously employed, in order to illustrate the experimental basis of the theory of volumes, and some other eudiometric phenomena.

As I find it very inconvenient not to have a name for every variety of apparatus, I shall call this instrument a Volumescope.

It consists of a very stout glass tube, of thirty-six inches in height, and tapering in diameter inside from two and one-eighth to one and one-eighth inches. The least thickness of the glass is at the lower end, and is there about five-eighths of an inch. There is an obvious increase in thickness, towards the top, within the space of about six inches. The tube is situated between the iron rods, I I, which are rivetted, at their lower ends, to a circular plate of the same metal let into the lower surface of a square piece of plank. This piece of plank supports the tube, so as to be concentric with an aperture corresponding with the bore of the tube, and constituting effectively its lower orifice. The upper orifice of the tube is closed by a stout block of mahogany, which receives a disk of greased leather in a corresponding hollow, formed, by means of a lathe, so as to be of the same diameter as the end of a tube. Into a perforation in the centre of

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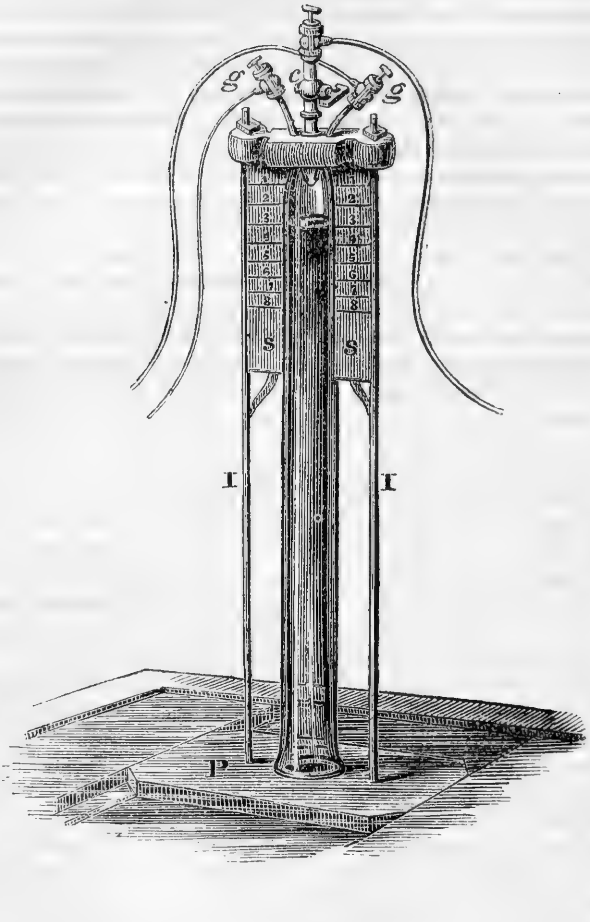
* See Article 124 of that work, fig. B.

Fig. 4.



the mahogany block, communicating with the bore of the tube, a cock, *c*, furnished with a gallows screw, is inserted. Through the block on each side of the perforation, wires are introduced, so as to be air-tight. To the upper end of these wires, gallows screws, *g g*, are attached. The lower ends of the wires, within the tube, are made to communicate by means of a fine platina wire fastened to them by solder.

The apparatus being so far prepared, let it be firmly fixed over the pneumatic cistern, so that the water may rise about an inch above the lower extremity of the tube. To the gallows screws, *g*, *g*, attach two leaden rods, severally proceeding from the poles of a calorimotor. By means of a leaden pipe, produce a communication between the bore of the cock, and an air pump, so that by pumping the air from the cavity of the tube, the water of the cistern may be made to rise into the space thus exhausted of air. On each side of the tube, and between it and each iron rod, there is a strip of wood scored so as to graduate about four inches of the tube into eight equal parts. These parts were measured by introducing into the tube, previously filled with water, one hundred measures of air, from a sliding rod gas measure, eight times, and marking the height of the water after every addition.* As each degree thus indicated by the strips will be equal to one hundred of those of the sliding rod, the whole may be considered either as comprising eight hundred measures of the latter, or as eight volumes, each divisible into one hundred parts, by means of the gas measure.

The apparatus being so far prepared, and the tube exhausted of air so as to become full of water, close the cock leading to the air pump, introduce two volumes of pure hydrogen, and one volume of pure oxygen, which may be most conveniently and accurately effected by the sliding rod gas measure. The plates of the calorimotor being in the next place excited by the acid, the ignition of the platina wire ensues, and causes the hydrogen and oxygen to explode. When they are pure, the subsequent condensation is so complete, that the water will produce a concussion as it rises forcibly against the leathern disk, which, aided by the mahogany block, has been represented as closing the upper orifice of the tube.

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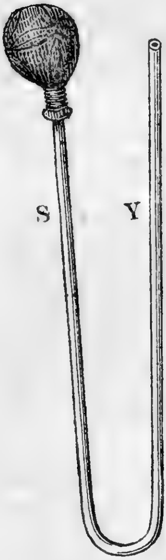
* See this Journal, vol. xii. page 39.

If the preceding experiment be repeated with an excess of either gas, it will be found that a quantity, equal to the excess, will remain after the explosion. This is very evident when the excess is just equal to one volume, because, in that case, just one volume will remain uncondensed. By these means, a satisfactory illustration is afforded of the simple and invariable ratio in which the gaseous elements of water unite, when mixed and inflamed; which is a fact of great importance to the atomic theory, and to the theory of volumes.

9. *Application of the Volumescope to the illustration of the ratio, in which nitric oxide, and the oxygen in atmospheric air, are condensed by admixture.*

Fig. 5.



The tube being filled with water by exhausting it of air, as in the preceding experiment, let five volumes of atmospheric air be introduced into it. Afterwards, by means of a volumeter, or sliding rod gas measure, add at once three volumes of nitric oxide. In the next place fill the syphon, S Y, and the caoutchouc bag attached to it with water, and pass the leg, Y, up through the bore of the eudiometer tube; then by alternate pressure and relaxation, the water may be propelled from the bag, through the syphon, into the gaseous mixture, so as to accelerate the absorption.

If in five volumes of atmospheric air there be one of oxygen gas, there will be just enough to condense two volumes of nitric oxide, by converting them into nitrous acid. Of course of the eight volumes in the tube, three will disappear and five remain. Hence the gas, after the absorption of the red fumes, will occupy the same space as the air before the introduction of the nitric oxide. The extent of the deviation, from this result, may be measured by introducing hydrogen by means of the sliding rod gas measure, until the quantity added causes the gas to extend to the next graduation. By these means, it is easy to ascertain how much the residue differs from five or six volumes. I have generally found it rather less than five volumes.

10. *Application of the Volumescope to the analysis of carbonic oxide, so as to show that the result confirms the theory of volumes.*

Carbonic oxide requiring for its saturation half its bulk of oxygen; in order to analyse it in the apparatus last described, after the preliminary preparations mentioned as necessary, in case of the gaseous elements of water, introduce two volumes of carbonic oxide, and one of oxygen gas, and ignite the platina wire. A feeble explosion will take place, and one volume will disappear. To complete the analysis, by means of a funnel screwed on to the cock inserted into the perforation in the mahogany block at the top of the eudiometer, lime water may be introduced, and thus all the carbonic acid, generated by the combustion of the carbonic oxide with the oxygen gas, may be absorbed. Of course, if the gases be pure, the absorption will be complete. It might perhaps be found preferable to introduce lime water by means of the syphon and bag, fig. 5.

11. ACCORDANCE OF THE ANALYSIS OF OLEFIANT GAS WITH THE THEORY OF VOLUMES, ILLUSTRATED BY THE VOLUMESCOPE.

As a volume of olefiant gas consists of two volumes of hydrogen, and two volumes of carbon vapour, if it be exploded with an excess of oxygen, say four volumes, all the hydrogen, and one volume of oxygen, will be converted into water. Meanwhile, two volumes of oxygen, uniting with two of carbon vapour, will constitute two volumes of carbonic acid. These may be absorbed by lime water introduced as in the case of carbonic oxide. It follows that one volume of oxygen will remain.

12. ANALYSIS OF A MIXTURE OF CARBONIC OXIDE, WITH ONE OR MORE OF THE GASEOUS COMPOUNDS OF CARBON WITH HYDROGEN.

If olefiant gas be present, it may be condensed by mingling, in any tall, narrow vessel protected from light, over water, one hundred measures of the mixture, with two hundred measures of chlorine; and at the end of about a quarter of an hour, agitating the residue with a caustic alkaline solution, to remove any excess of the last mentioned gas.*

* See Traité de Chimie par Thenard, vol. v. page 34.

The measurement may be easily performed by means of the sliding rod eudiometer,* the residue being transferred into, and measured from the receiver, fig. 2, same page, agreeably to the instructions given in the case of nitric oxide.

The bihydroguret of carbon, usually called carburetted hydrogen,† consists of two volumes of hydrogen and one of carbon condensed into one volume. This gas not being condensible by chlorine, when light is excluded, a mixture of it with carbonic oxide, should be analysed by the following process.

Being mixed with three times its bulk of oxygen gas within the bell glass, O N, communicating with the receiver of the sliding rod eudiometer, an adequate quantity may be exploded, pursuant to the directions in the case of carbonic oxide, and olefiant gas.

More than half a cubic inch of the gaseous mixture, with the necessary addition of oxygen, cannot be safely exploded at once in any ordinary eudiometer; but by successive operations a large quantity may be exploded, and inferences may be founded upon the accumulated result.

Let it be imagined that the relative weights of the gaseous mixture in question, of the oxygen gas added to it, and of the carbonic acid produced, have been calculated by multiplying their respective quantities, as ascertained by the eudiometer, by their specific gravities.‡

Since a mixture of carbonic oxide and bihydroguret of carbon, by combustion with an excess of oxygen, must be wholly converted into water and carbonic acid; and since the carbonic acid is entirely absorbed by lime water, it follows that the residual gas must be the unconsumed portion of the oxygen gas added to the mixture. Deducting this residual oxygen from the whole quantity of this gas employed, the remainder is the quantity consumed. The weight of the oxygen consumed, with the weight of the gaseous mixture, must constitute the whole weight of the products, consisting, according to the premises, of water and carbonic acid only, and deducting the latter, the remainder will be the whole

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* See this Journal, vol. x. page 76, fig. 6.

† It is sometimes called light carburetted hydrogen.

‡ The specific gravities of oxygen gas, of carbonic oxide, and of carbonic acid, may be known from the table, page 196, Compendium. That of the gaseous mixture may be ascertained, agreeably to the instructions in article 184, Compendium.

weight of the water generated. Of this, agreeably to the table of equivalents, $\frac{8}{9}$ths must be oxygen, and $\frac{1}{9}$th hydrogen.

And since the ratio of the carbon to the oxygen, in carbonic acid, is as 75 to 200, $\frac{75}{275}$ths or $\frac{3}{11}$ths of the weight of the acid produced, will be carbon, and $\frac{200}{275}$ths or $\frac{8}{11}$ths oxygen. If we add, therefore, $\frac{8}{9}$ths of the weight of the water to $\frac{8}{11}$ths of that of the acid, we shall have the weight of all the oxygen in the products. If from the weight, thus ascertained, we deduct that of all the oxygen gas consumed, the remainder will be the weight of oxygen in the mixture before the oxygen gas was added. This portion of oxygen is that which entered into the composition of the carbonic oxide, and must, agreeably to the table of equivalents, have been to the carbon in union with it, as four to three. Deducting the weight of the carbon, thus ascertained to exist in the carbonic oxide, from that in the carbonic acid, as above stated, the remainder will be the weight of carbon in the carburetted hydrogen.

The rule may be thus briefly expressed.

From the sum of the weights of the gaseous mixture, and oxygen gas consumed, deduct the carbonic acid generated. To eight-ninths of the remainder, add eight-elevenths of the weight of the carbonic acid, and deduct the weight of oxygen consumed. The remainder will be the oxygen of the oxide. The carbon in it will be one-fourth less, and this carbon deducted from three-elevenths of the weight of the carbonic acid, will give the weight of the carbon united to the hydrogen.*

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* The problem may be stated algebraically as follows:—
Let M be the weight of the gaseous mixture.
O, of the oxygen gas consumed.
C, of the carbonic acid generated and absorbed.
Then $M+O$ will constitute the whole weight of the products.
And $M+O-C$ the whole weight of water.

Also $\frac{8}{9}(M+O-C)=$ all the oxygen in the water.

$\frac{8C}{11}$ will be all the oxygen in the carbonic acid.

$\frac{3C}{11}$ all the carbon in that acid, and consequently the whole contained in the products.

$\frac{8}{9}(M+O-C)+\frac{8C}{11}$ will be all the oxygen in the products.

When there is a copious supply of the gas to be examined, the barometer gage eudiometer may be used advantageously, as much larger quantities of gas may be exploded in it, than could be exploded in the same time, in the sliding rod eudiometer.*

In order to render the process with the barometer gage eudiometer safe, the quantity introduced in the first instance should be as small as can be ignited. Afterwards successive portions may be introduced and exploded, until the receiver be nearly full of the residual gas. That this operation may be still more secure, I propose to employ, as a receiver, an iron bottle (such as are used to hold mercury) surmounted by a very stout glass tube, in which the platina wire may be situated, which is to cause ignition. This tube would be the only part of the apparatus which it would be desirable to have transparent. Indeed transparency may be dispensed with altogether, the explosion being perceptible from the noise, and the effect upon the gage.

And $\frac{8}{9}(M+O-C)+\frac{8C}{11}-0$ will be that portion of oxygen which existed previously in the gas, which call X.

We have therefore the following equation:

$$X=\frac{8M+8O-8C}{9}+\frac{8C}{11}-O.$$

which may be thus reduced:

$$X=\frac{88M+88O-88C+72C}{99}-O.$$

$$X=\frac{88M+88O-16C}{99}-O.$$

$$X=\frac{88M+88O-16C-99O}{99}$$

$$X=\frac{88M-16C-11O}{99}$$

It follows from the atomic weights, and the premises, that $\frac{3X}{4}$ = the carbon in carbonic oxide. And $X+\frac{3X}{4}$ = weight of carbonic oxide.

Also $\frac{3C}{11}-\frac{3X}{4}$ = the carbon united to hydrogen.

And $\frac{3C}{11}-\frac{3X}{4}+\frac{M+O-C}{9}$ = weight carburetted hydrogen.

* See this Journal, vol. xii. page 46.

13. ANALYSIS OF A GASEOUS MIXTURE, IN WHICH BIHYDROGURET OF CARBON, CARBONIC OXIDE, AND EITHER HYDROGEN OR NITROGEN, OR BOTH THE LATTER, ARE INTERMINGLED.

When, as in the case under consideration in the preceding article, there is no nitrogen present, the gas which remains after the action of the lime-water, may be considered as oxygen; but if nitrogen be present, the residual gas must be analysed in order to ascertain the quantity of oxygen which remains unconsumed.

This is easily accomplished by propelling the residual gas into the receptacle for carbonic acid, R, fig. 1, and substituting a self-regulating reservoir of hydrogen for the bell glass. Then having filled the gage and pipes with the pure hydrogen, by the manipulation already described in the case of oxygen, (article 2,) the residual gas may be drawn into the receiver, exploded, and the resulting deficit ascertained—to one-third of which the oxygen is equivalent.

Instead of resorting to the method just mentioned, the residual gas, after being included in the receptacle, may be transferred to the pneumatic cistern, and analysed by the aqueous sliding rod eudiometer.*

If we subtract from the weight of the "*residual gas*" the weight of the oxygen found in it, the remainder being both incombustible and insusceptible of absorption by lime water, should be considered as the weight of the nitrogen. This would have to be deducted from that of the gaseous mixture, the calculation being otherwise unaltered.

If after having analysed a gaseous mixture, agreeably to the directions given in the last article, it be found that the quantity of hydrogen indicated exceed, in weight, one third of the carbon allotted to it, the excess must be considered as pure hydrogen: since, agreeably to the table of equivalents, the weight of the carbon, in the bihydroguret, is to the hydrogen, as 3 to 1.†

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* See Memoir, vol. x. page 67 of this Journal.

† That is, putting H for the pure hydrogen, we should have

$$H=\frac{M+O-C}{9}-\frac{1}{3}\left(\frac{3C}{11}-\frac{3X}{4}\right)$$

14. METHOD OF ASCERTAINING THE PROPORTIONS OF BIHYDROGURET OF CARBON AND CARBONIC OXIDE, IN A MIXTURE OF THOSE GASES, PROVIDED NO OTHER INFLAMMABLE GAS BE PRESENT. BY FRANKLIN BACHE, M. D., &c. &c. &c.

I will here subjoin an excellent method of ascertaining the proportions of bihydroguret of carbon and carbonic oxide, in a mixture of those gases, which has been ingeniously and correctly suggested by my friend Dr. Bache.

"The proportion of carbonic oxide, in a mixture of this gas and bihydroguret of carbon, may be calculated from the quantity of oxygen consumed by them when exploded, in the following manner.

"If we suppose a gas to be all bihydroguret of carbon, it will consume twice its volume of oxygen: if, on the other hand, it be all carbonic oxide, it will require half its volume for complete combustion. It must be evident, therefore, that a mixture of these gases will consume a volume of oxygen, intermediate between half the volume and twice the volume of the mixture; and that whatever may be the volume of the oxygen consumed, it will bear a constant proportion to the carbonic oxide present.

"Reasoning from the analysis of the pure bihydroguret, which requires twice its volume for complete combustion, it must be apparent, that the introduction of the least portion of carbonic oxide will necessarily diminish the quantity of the oxygen consumed. Now it will be found, that this diminution of the quantity of the oxygen required, bears to the carbonic oxide present, the constant ratio of 3 to 2. Hence we have this proportion:—

"As 3 is to 2,

So is the deficit of oxygen above alluded to, to the carbonic oxide present.

"This mode of calculating the carbonic oxide in the mixture supposed, may be expressed in an algebraic formula, as follows:—

"Let M = volume of the gaseous mixture, and
O = oxygen consumed.

$$\text{Then } \frac{2\,M - O \times 2}{3} = \text{vol. of carbonic oxide present.}$$

And as carbonic oxide contains half its volume of oxygen, then

$$\frac{2M-O}{3} = \text{vol. of oxygen in the carbonic oxide.''}$$

This method is evidently preferable in the case of a mixture known to consist of pure bihydroguret and carbonic oxide: but unfortunately it is inapplicable if hydrogen be present in any other state than as a definite compound with carbon, requiring twice its volume of oxygen for saturation. The process of Dr. Bache is not competent to inform us what the gases are; but enables us, when their nature is known, to discover their proportions.

ART. VI.—*On the Saccharum of the Sweet Potato (Convolvulus battatas;) by* ROBERT HARE, M. D., Professor of Chemistry in the University of Pennsylvania.

DR. TIDYMAN, of South Carolina, lately supplied me with some sweet potatoes, of a kind in which sweet matter is peculiarly abundant, and requested that I would ascertain if there were any sugar in them. Having pared, and by means of the instrument used for slicing cabbages or cucumbers, reduced them to very thin slices; about a pound was boiled in alcohol of the specific gravity of .845, which appeared to extract all the sweetness, yet on cooling yielded no crystals of sugar. The solution being subjected to distillation, till the alcohol was removed, an uncrystallizable syrup remained. In like manner, when aqueous infusions of the potatoes were concentrated, by boiling or evaporation, the residual syrup was uncrystallizable. It appears therefore that the sweet matter of this vegetable is analogous to molasses, or the saccharum of malt.

Its resemblance to the latter was so remarkable, that I was led to boil a wort, made from the potatoes, of proper spissitude, say s. g. 1060, with a due quantity of hops, about two hours.

It was then cooled to about sixty-five degrees, and yest was added. As far as I could judge, the phenomena of the fermentation, and the resulting liquor, were precisely the same as if malt had been used. The wort was kept in a warm place until the temperature 85 F. and the fall of the head showed the attenuation to be sufficient.* Yest sub-

* In passing to this state, there should be a loss in gravity of about four per cent.

sequently rose, which was removed by a spoon. By refrigeration a further quantity of yest precipitated, from which the liquor being decanted became tolerably fine, for new beer, and, in flavour, exactly like ale made from malt.

I have computed that five bushels of potatoes would produce as much wort as three bushels of malt; but I suppose that the residue would, as food for cattle, be worth half as much as the potatoes employed.

I believe it possible to make as good liquor from malt in this country, as in England, but that in our climate much more vigilance is required to have it invariably good, principally because the great and sudden changes of temperature, render malting much more precarious. Should the saccharum of the sweet potato prove to be a competent substitute for that of germinated grain, the quality will probably be less variable, since its development requires but little skill and vigilance.

Besides, as it exists naturally in the plant, it may be had where it would be almost impossible to make, or procure malt. Hops, the other material for beer, require only picking and drying to perfect them for use.

They are indigenous in the United States, and no doubt may be raised in any part of our territory.

I have dried, in my evaporating oven, some of the sweet potatoes in slices. It seems to me that in this state they will keep a long while, and may be useful in making leaven for bread. They may take the place of the malt necessary in a certain proportion, to render distillers' wash fermentable. The yest yielded by the potato beer appeared in odour and flavour to resemble that from malt beer surprisingly, and the quantity, in proportion, was as great. In raising bread, it was found equally efficacious.

I propose the word suavin, from the Latin suavis, sweet, to distinguish the syrup of the sweet potato. The same word might, perhaps, be advantageously applied as a generic appellation to molasses, and the uncrystallizable sugar of grapes, of honey, and of malt.

Crystallizable sugar might be termed saccharin, since the terminating syllable of saccharum is appropriated in chemistry to metals.

Art. VII.—*A Synoptical Table of the Ferns and Mosses of the United States; by* Lewis C. Beck, M. D.

TO PROFESSOR SILLIMAN.

Although much attention has been paid to the phenogamous plants of the United States, our Cryptogamiæ have been in a measure neglected. This cannot be ascribed to a want of interest in their investigation, but to the difficulty which attends it. This difficulty arises chiefly from the fact that there have been no separate publications upon these plants;—the brief notices and descriptions of some of them which are found in general works upon American Botany, being altogether insufficient for the purposes of accuracy.

Some years since I began to devote particular attention to our native Ferns and Mosses; but I soon found that I could not proceed far without having recourse to more detailed descriptions than are usually met with in the works just mentioned. Having the good fortune to be within reach of many standard foreign works upon these orders, I conceived the plan of preparing, for my own convenience, a Manual of the Ferns and Mosses of the United States. Having completed the task, I have now determined to publish this Manual, in the hope that it may offer some facilities for the study of these families.

This work, which is now ready for the press, will contain —a general view of the Anatomy and Physiology of the Ferns and Mosses;—detailed descriptions of the genera and species hitherto known as natives of the United States;—a copious glossary of the terms employed;—with accurate engravings of all the genera. The following is a Synoptical Table of the genera and species, which I am induced to offer for publication in your valuable journal, with a view of directing the attention of our botanists to the undertaking, and of soliciting from them such additional information as they may possess.

Yours respectfully,

Lewis C. Beck.

Albany, November, 1828.

FERNS.

Division I. *Capsules furnished with an elastic ring.*

A. *Without Involucres.*

I. Acrostichum. *Linn.*

1. A. aureum.

II. Polypodium. *Linn.*

1. P. vulgare.
2. P. incanum.
3. P. phegopteris.
4. P. connectile.
5. P. dryopteris.

B. *With Involucres.*

III. Aspidium. *Swartz.*

* *Frond ternate.*

1. A. cicutarium.

** *Frond pinnate.*

2. A. acrostichoides.

*** *Frond sub-bipinnate.*

3. A. noveboracense.
4. A. cristatum.

**** *Frond doubly and triply pinnate.*

5. A. aculeatum.
6. A. goldianum.
7. A. marginale.
8. A. dilatatum.
9. A. spinulosum.
10. A. fragile.
11. A. bulbiferum.
12. A. asplenoides.
13. A. tenue.
14. A. punctilobum.

IV. Hippopeltis. *Brown.*

1. H. obtusa.

V. Woodsia. *Brown.*

1. W. ilvensis.
2. W. hyperborea.
3. W. glabella.

VI. Onoclea. *Linn.*

1. O. sensibilis.

VII. Struthiopteris. *Willd.*

1. S. pennsylvanica.

VIII. CRYPTOGRAMMA. *Brown.*

1. C. acrostichoides.

IX. BLECHNUM. *Linn.*

1. B. boreale.
2. B. serrulatum.

X. PTERIS. *Linn.*

1. P. pedata.
2. P. atropurpurea.
3. P. gracilis?
4. P. candata.
5. P. aquilina.

XI. VITTARIA. *Smith.*

1. V. lineata.

XII. ASPLENIUM. *Linn.*

1. A. rhizophyllum.
2. A. angustifolium.
3. A. ebeneum.
4. A. trichomanes.
5. A. thelypteroides.
6. A. ruta-muraria.
7. A. montanum.

XIII. SCOLOPENDRIUM. *Smith.*

1. S. vulgare.

XIV. WOODWARDIA. *Smith.*

1. W. angustifolia.
2. W. virginica.
3. W. thelypteroides.

XV. ADIANTUM. *Linn.*

1. A. pedatum.

XVI. CHEILANTHUS. *Swartz.*

1. C. vestita.
2. C. dealbata.

XVII. HYMENOPHYLLUM. *Smith.*

1. H. ciliatum.

DIVISION II. *Capsules without a ring.*

XVIII. SCHIZEA. *Smith.*

1. S. pusilla.

XIX. OSMUNDA. *Linn.*

1. O. cinnamomea.
2. O. alata.
3. O. interrupta.
4. O. regalis.

XX. Lygodium. *Swartz.*

1. L. palmatum.

XXI. Botrychium. *Swartz.*

1. B. simplex.
2. B. fumaroides.
3. B. dissectum.
4. B. virginianum.

XXII. Ophioglossum. *Linn.*

1. O. vulgatum.
2. O. bulbosum.
3. O. pusillum.

Lycopodineæ.

XXIII. Lycopodium. *Linn.*

* *Spikes peduncled.*

1. L. carolinianum.
2. L. clavatum.
3. L. integrifolium.
4. L. complanatum.
5. L. alpinum.

** *Spikes sessile; leaves surrounding the stem.*

6. L. dendroideum.
7. L. annotinum.
8. L. inundatum.
9. L. selaginoides.
10. L. alopecuroides.
11. L. rupestre.

*** *Spikes sessile; leaves 2-ranked.*

12. L. apodum.

**** *Fruit axillary.*

13. L. lucidulum.
14. L. selago.

Marsiliaceæ.

XXIV. Isoetes. *Linn.*

1. I. lacustris.

XXV. Psilotum. *Swartz.*

1. P. triquetrum.

XXVI. Salvinia. *Mich.*

1. S. natans.

XXVII. Azolla. *Lamark.*

1. A. caroliniana.

Equisetaceæ.

XXVIII. Equisetum. *Linn.*

* *Fertile stems simple.*

1. E. arvensis.
2. E. hyemale.

** *Fertile stems more or less branched.*

3. E. limosum.
4. E. scirpoides.
5. E. palustre.
6. E. sylvaticum.
7. E. umbrosum.

MOSSES.

Division I. *Capsules without Peristomes.*

A. *Lid persistent.*

I. Andrœa. *Ehrh.*

1. A. alpina.
2. A. rupestris.

II. Phascum. *Linn.*

* *Leaves lanceolate or subulate.*

1. P. serratum.
2. P. crispum.

** *Leaves more or less ovate.*

3. P. coherens.
4. P. muticum.
5. P. patens.
6. P. subulatum.
7. P. curvicollum.
8. P. carinatum.
9. P. flexuosum.
10. P. muhlenbergianum.

B. *Lid deciduous.*

III. Sphagnum. *Linn.*

1. S. latifolium.
2. S. squarrosum.
3. S. capillifolium.
4. S. cuspidatum.

IV. Gymnostomum. *Hedw.*

1. G. pyriforme.
2. G. turbinatum.
3. G. lapponicum.
5. G. rupestre.

V. Anictangium. *Hedw.*

1. A. ciliatum.
2. A. filiforme.

Division II. *Capsules with Peristomes.*

A. *Peristomes single.*

1. *Fruit stalks terminal.*

VI. Diphyscium. *Web and Mohr.*

1. D. foliosum.

VII. Tetraphis. *Hedw.*

1. T. pellucida.

VIII. Grimmia. *Ehrh.*

1. G. apocarpa.
2. G. pilifera.
3. G. tortilis.
4. G. incurva.
5. G. sudetica.
6. G. pulvinata.
7. G. gracilis.
8. G. ovata.

IX. Weissia. *Hedw.*

1. W. microdonta.
2. W. curvirostra.
3. W. controversa.
4. W. verticillata.
5. W. cirrata.

X. Encalypta. *Hedw.*

1. E. pilifera.
2. E. ciliata.
3. E. streptocarpa.
4. E. rhaptocarpa.

XI. Dicranum. *Hedw.*

A. *Leaves 2-ranked.*

1. D. bryoides.
2. D. adiantoides.
3. D. taxifolium.

B. *Leaves inserted on all sides of the stem.*

a. Leaves destitute of a nerve.

4. D. glaucum.

b. Leaves furnished with a nerve.

5. D. latifolium.
6. D. longifolium.
7. D. cerviculatum.

† *Capsule with a Struma.*

8. D. virens.
9. D. strumiferum.
10. D. polycarpum.
11. D. ambiguum.

†† *Capsules without a Struma.*

12. D. scottianum.
13. D. undulatum.
14. D. scoparium.
15. D. varium.
16. D. heteromallum.
17. D. xanthodon.
18. D. condensatum.

XII. Didymodon. *Hedw.*

a. *Capsules inclined.*

1. D. purpureum.
2. D. inclinatum.

b. *Capsules erect, or nearly so.*

3. D. glaucescens.
4. D. rigidulum.
5. D. trifarium.
6. D. capillaceum.
7. D. pallidum.

XIII. Trichostomum. *Hedw.*

1. T. lanuginosum.
2. T. canadense.
3. T. microcarpon.
4. T. tenue.

XIV. Splachnum. *Linn.*

1. S. ampullaceum.
2. S. angustatum.

Several others, natives of Arctic America.

XV. Tortula. *Hedw.*

A. *Leaves of the perichætium convolute.*

1. T. convoluta.

B. *Leaves uniform.*

† *Piliferous.*

2. T. muralis.
3. T. ruralis.

†† *Leaves mucronate.*

a. Peristome tubular beyond the middle.

4. T. mucronifolia.
5. T. leucostema.
6. T. subulata.

b. *Teeth of the peristome almost entirely free.*

7. T. unguiculata.
8. T. cæspitosa.

††† *Leaves awnless.*

9. T. tortuosa.
10. T. fallax.
11. T. humilis.

2. *Fruit stalks lateral.*

XVI. Pterogonium. *Swartz.*

1. P. trichomitrion.
2. P. marginatum.
3. P. intricatum.
4. P. julaceum.
5. P. brachycladon.
6. P. hirtellum.
7. P. sub-capillatum.

XVII. Leucodon. *Schwægr.*

1. L. sciuroides.

B. *Peristomes double.*

1. *Fruitstalks terminal.*

XVIII. Polytrichum. *Linn.*

* *Calyptra naked.*

1. P. undulatum.

** *Calyptra hairy.*

2. P. piliferum.
3. P. juniperinum.
4. P. commune.
5. P. alpinum.
6. P. dentatum.
7. P. urnigerum.
8. P. pennsylvanicum.
9. P. capillare.
10. P. brachyphyllum.

XIX. Orthotrichum. *Hedw.*

† *Peristome simple.*

a. *Capsules immersed.*

1. O. cupulatum.

b. *Capsules exsert.*

2. O. clavellatum.
3. O. anomalum.

†† *Peristomes double.*

a. Capsules immersed.

* *Inner of* 8*-ciliary processes.*

4. O. affine.
5. O. rupestre.
6. O. elegans.
7. O. obtusifolium.

** *Ciliæ* 16.

8. O. striatum.
9. O. Lyellii.

b. Capsules exsert.

* *Ciliæ* 8.

10. O. speciosum.
11. O. Hutchinsiæ.
12. O. Ludwigii.
13. O. coarctatum.
14. O. crispum.

XX. Bartramia. *Hedw.*

1. B. gracilis.
2. B. pomiformis.
3. B. ithyphylla.
4. B. fontana.
5. B. Menziesii.

XXI. Bryum. *Dill.*

Division I. *Capsule furrowed.*

1. B. androgynum.
2. B. palustre.
3. B. arrhenopterum.

Division II. *Capsule smooth.*

A. *Teeth of the outer peristome shorter than the inner one.*

4. B. triquetrum.
5. B. trichodes.

B. *Teeth of the outer peristome as long as the inner one.*

† *Leaves without any thickened margin.*

6. B. pyriforme.
7. B. crudum.
8. B. carneum.
9. B. argenteum.
10. B. roseum.
11. B. cæpititium.
12. B. nutans.
13. B. alpinum.
14. B. ventricosum.
15. B. julaceum.

†† *Leaves with their margins thickened.*

16. B. punctatum.
17. B. rostratum.
18. B. marginatum.
19. B. hornum.
20. B. cuspidatum.
21. B. ciliare.
22. B. turgidum.
23. B. affine.

XXII. Timmia. *Hedw.*

1. T. megapolitana.

XXIII. Buxbaumia. *Linn.*

1. B. aphylla.

XXIV. Funaria. *Hedw.*

1. F. hygrometrica.
2. F. flavicans.
3. F. Muhlenbergii.
4. F. patens.

XXV. Neckera. *Hedw.*

1. N. pennata.
2. N. macropoda.
3. N. seductrix.
4. N. cladorhizans.
5. N. viticulosa.
6. N. heteromalla.

XXVI. Hookeria. *Smith.*

1. H. lucens.
2. H. rigida?

XXVII. Hypnum. *Dill.*

Division I. *Stems (taken in conjunction with the leaves) plane.*

1. H. riparium.
2. H. denticulatum.

Division II. *Stems (taken in conjunction with the leaves) more or less cylindrical, never plane.*

* *Leaves spreading on all sides of the stem.*

A. *Leaves uniform in their direction.*

a. Nerve reaching to, or beyond the point.

3. H. medium.
4. H. serpens.
5. H. papuleum.
6. H. spiniforme?
7. H. varium.
8. H. fasciculosum.
9. H. imbricatum.
10. H. acuminatum.
11. H. ———*
12. H. rostratum.
13. H. rupincolum.
14. H. tenax.

b. Nerve shorter than the leaf, or none.

15. H. shreberi.
16. H. stramineum.
17. H. pulchellum.
18. H. salebrosum.
19. H. lutescens.
20. H. nitens.
21. H. albicans.
22. H. alopecurum.
23. H. splendens.
24. H. dendroides.
25. H. proliferum.
26. H. prælongum.
27. H. abietinum.
28. H. rutabulum.
29. H. velutinum.
30. H. prolixum.
31. H. confertum.
32. H. striatum.
33. H. adnatum.
34. H. illecebrum.

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* The specific word was obliterated by the seal.

35. H. minitulum.
36. H. curvifolium.
37. H. haldanianum.

B. *Leaves squarrose.*

38. H. cuspidatum.
39. H. polymorphum.
40. H. stellatum.
41. H. dimorphum.
42. H. triquetrum.
43. H. squarrosum.

** *Leaves secund.*

a. *Leaves furnished with a single nerve.*

44. H. filicinum.
45. H. atrovirens.
46. H. palustre.
47. H. fluitans.
48. H. aduncum.
49. H. uncinatum.
50. H. commutatum.
51. H. attenuatum.

b. *Leaves destitute of a nerve or furnished with two very indistinct ones at the base.*

52. H. scorpiodies.
53. H. silesianum.
54. H. cupressiforme.
55. H. crista-castrensis.
56. H. molluscum.
57. H. imponens.

XXVIII. FONTINALIS. *Linn.*

1. F. antipyretica.
2. F. squarrosa.
3. F. capillacea.
4. F. subulata.

ART. VIII.—*Original Papers in relation to a Course of Liberal Education.*

REMARKS BY THE EDITOR.

THE following papers relate to an important subject, respecting which there is at present some diversity of opinion. As the interests of sound learning, in relation both to literature and science, and to professional and active life, are intimately connected with the views developed in the subjoined reports, they are therefore inserted in this Journal, in the belief that they will be deemed both important and interesting by its readers.

At a Meeting of the President and Fellows of Yale College, Sept 11th, 1827, the following resolution was passed:

That His Excellency Governor Tomlinson, Rev. President Day, Rev. Dr. Chapin, Hon. Noyes Darling, and Rev. Abel

McEwen, be a committee to inquire into the expediency of so altering the regular course of instruction in this college, as to leave out of said course the study of the *dead languages*, substituting other studies therefor; and either requiring a competent knowledge of said languages, as a condition of admittance into the college, or providing instruction in the same, for such as shall choose to study them after admittance; and that the said committee be requested to report at the next annual meeting of this corporation.

This committee, at their first meeting in April, 1828, after taking into consideration the case referred to them, requested the Faculty of the college to express their views on the subject of the resolution.

The expediency of retaining the ancient languages, as an essential part of our course of instruction, is so obviously connected with the object and plan of education in the college, that justice could not be done to the particular subject of inquiry in the resolution, without a brief statement of the nature and arrangement of the various branches of the whole system. The report of the faculty was accordingly made out in *two parts;* one containing a summary view of the plan of education in the college; the other, an inquiry into the expediency of insisting on the study of the ancient languages.

This report was read to the committee, at their meeting in August. The committee reported their views to the corporation, at their session in September; who voted to accept the report, and ordered it to be printed, together with the papers read before the committee, or such parts of them as the prudential committee and the faculty should judge it expedient to publish.

REPORT OF THE FACULTY.

PART I.

Containing a summary view of the plan of education in the college.

The committee of the corporation, to whom was referred the motion, to inquire into the expediency of dispensing with the study of the ancient languages, as a part of the regular course of instruction in this college, having requested the views of the faculty on the subject, we would respectfully submit the following considerations.

We are decidedly of the opinion, that our present plan of education admits of improvement. We are aware that the system is imperfect: and we cherish the hope, that some of its defects may ere long be remedied. We believe that changes may, from time to time be made with advantage, to meet the varying demands of the community, to accommodate the course of instruction to the rapid advance of the country, in population, refinement, and opulence. We have no doubt that important improvements may be suggested, by attentive observation of the literary institutions in Europe; and by the earnest spirit of inquiry which is now so prevalent, on the subject of education.

The guardians of the college appear to have ever acted upon the principle, that it ought not to be stationary, but continually advancing. Some alteration has accordingly been proposed, almost every year, from its first establishment. It is with no small surprise, therefore, we occasionally hear the suggestion, that our system is unalterable; that colleges were originally planned, in the days of monkish ignorance; and that, "by being immovably moored to the same station, they serve only to measure the rapid current of improvement which is passing by them."

How opposite to all this, is the real state of facts, in this and the other seminaries in the United States. Nothing is more common, than to hear those who revisit the college, after a few years absence, express their surprise at the changes which have been made since they were graduated. Not only the course of studies, and the modes of instruction, have been greatly varied; but whole sciences have, for the first time, been introduced; chemistry, mineralogy, geology, political economy, &c. By raising the qualifications for admission, the standard of attainment has been elevated. Alterations so extensive and frequent, satisfactorily prove, that if those who are intrusted with the superintendence of the institution, still firmly adhere to some of its original features, it is from a higher principle, than a blind opposition to salutary reform. Improvements, we trust, will continue to be made, as rapidly as they can be, without hazarding the loss of what has been already attained.

But perhaps the time has come, when we ought to pause, and inquire, whether it will be sufficient to make *gradual* changes, as heretofore; and whether the whole system is not rather to be broken up, and a better one substituted in its stead. From different quarters, we have heard the suggestion, that our colleges must be *new-modelled;* that they are not adapted to the spirit and wants of the age; that they will soon be deserted, unless they are better accommodated to the business character of the nation. As this point may have an important bearing upon the question immediately before the committee, we would ask their indulgence, while we attempt to explain, at some length, the nature and object of the present plan of education at the college.

We shall in vain attempt to decide on the expediency of retaining or altering our present course of instruction, unless we have a distinct apprehension of the *object* of a collegiate education. A plan of study may be well adapted to a particular purpose, though it may be very unsuitable for a different one. Universities, colleges, academical, and professional seminaries, ought not to be all constituted upon the same model; but should be so varied as to attain the ends which they have severally in view.

What then is the appropriate object of a college? It is not necessary here to determine what it is which, in every case, entitles an institution to the *name* of a college. But if we have not greatly misapprehended the design of the patrons and guardians of this college, its object is to LAY THE FOUNDATION of a SUPERIOR EDUCATION: and this is to be done, at a period of life when a substitute must be provided for *parental superintendence.* The ground work of a thorough education, must be broad, and deep, and solid. For a partial or superficial education, the support may be of looser materials, and more hastily laid.

The two great points to be gained in intellectual culture, are the *discipline* and the *furniture* of the mind; expanding its powers, and storing it with knowledge. The former of these is, perhaps, the more important of the two. A commanding object, therefore, in a collegiate course, should be, to call into daily and vigorous exercise the faculties of the student. Those branches of study should be prescribed, and those modes of instruction adopted, which are best calculated to teach the art of fixing the attention, directing the train of thought, analyzing a subject proposed for investigation; following, with accurate discrimination, the course of argument; balancing nicely the evidence presented to the judgment; awakening, elevating, and controlling the imagination; arranging, with skill, the treasures which memory gathers; rousing and guiding the powers of genius. All this is not to be effected by a light and hasty course of study; by reading a few books, hearing a few lectures, and spending some months at a literary institution. The habits of thinking are to be formed, by long continued and close application. The mines of science must be penetrated far below the surface, before they will disclose their treasures. If a dexterous performance of the manual operations, in many of the mechanical arts, requires an apprenticeship, with diligent attention for years; much more does the training of the powers of the mind demand vigorous, and steady, and systematic effort.

In laying the foundation of a thorough education, it is necessary that *all* the important mental faculties be brought into exercise. It is not sufficient that one or two be cultivated, while others are neglected. A costly edifice ought not to be left to rest upon a single pillar. When certain mental endowments receive a much higher culture than others, there is a distortion in the intellectual character. The mind never attains its full perfection, unless its various powers are so trained as to give them the fair proportions which nature designed. If the student exercises his reasoning powers only, he will be deficient in imagination and taste, in fervid and impressive eloquence. If he confines his attention to demonstrative evidence, he will be unfitted to decide correctly, in cases of probability. If he relies principally on his memory, his powers of invention will be impaired by disuse. In the course of instruction in this college, it has been an object to maintain such a proportion between the different branches of literature and science, as to form in the student a proper *balance* of character. From the pure mathematics, he learns the art of demonstrative reasoning. In attending to the physical sciences, he becomes familiar with facts, with the process of induction, and the varieties of probable evidence. In ancient literature, he finds some of the most finished models of taste. By English reading, he learns the powers of the language in which he is to speak and write. By logic and mental philosophy, he is taught the art of thinking; by rhetoric and oratory, the art of speaking. By frequent exercise on written composition, he acquires copiousness and accuracy of expression. By extemporaneous discussion, he becomes prompt, and fluent, and animated. It is a point of high importance, that eloquence and solid learning should go together; that he who has accumulated the richest treasures of thought, should possess the highest powers of oratory. To what purpose has a man become deeply learned, if he has no faculty of communicating his knowledge? And of what use is a display of rhetorical elegance, from one who knows little or nothing which is worth communicating? Est enim scientia comprehendenda rerum plurimarum, sine qua verborum volubilitas inanis atque irridenda est. Cic. Our course, therefore, aims at a union of science with literature; of solid attainment with skill in the art of persuasion.

No one feature in a system of intellectual education, is of greater moment than such an arrangement of duties and motives, as will most effectually throw the student upon the *resources of his own mind.* Without this, the whole apparatus of libraries, and instruments, and specimens, and lectures, and teachers, will be insufficient to secure distinguished excellence. The scholar must form himself, by his own exertions. The advantages furnished by a residence at a college, can do little more than stimulate and aid his personal efforts. The *inventive* powers are especially to be called into vigorous exercise. However abundant may be the acquisitions of the student, if he has no talent at forming new combinations of thought, he will be dull and inefficient. The sublimest efforts of genius consist in the creations of the imagination, the discoveries of the intellect, the conquests by which the dominions of science are extended. But the culture of the inventive faculties is not the *only* object of a liberal education. The most gifted understanding cannot greatly enlarge the amount of science to which the wisdom of ages has contributed. If it were possible for a youth to have his faculties in the highest state of cultivation, without any of the knowledge which is derived from others, he would be but poorly fitted for the business of life. To the discipline of the mind, therefore, is to be added instruction. The analytic method must be combined with the synthetic. Analysis is most efficacious in directing the powers of invention; but is far too slow in its progress to teach, within a moderate space of time, the circle of the sciences.

In our arrangements for the communication of knowledge, as well as in intellectual discipline, such branches are to be taught as will produce a proper symmetry and balance of character. We doubt whether the powers of the mind can be developed, in their fairest proportions, by studying languages alone, or mathematics alone, or natural or political science alone. As the bodily frame is brought to its highest perfection, not by one simple and uniform motion, but by a variety of exercises; so the mental faculties are expanded, and invigorated, and adapted to each other, by familiarity with different departments of science.

A most important feature in the colleges of this country is, that the students are generally of an age which requires, that a substitute be provided for *parental superintendence.* When removed from under the roof of their parents, and exposed to the untried scenes of temptation, it is necessary that some faithful and affectionate guardian take them by the hand, and guide their steps. This consideration determines the *kind* of government which ought to be maintained in our colleges. As it is a substitute for the regulations of a family, it should approach as near to the character of parental control as the circumstances of the case will admit. It should be founded on mutual affection and confidence. It should aim to effect its purpose, principally by kind and persuasive influence; not wholly or chiefly by restraint and terror. Still, punishment may sometimes be necessary. There may be perverse members of a college, as well as of a family. There may be those whom nothing but the arm of law can reach.

The parental character of college government, requires that the students should be so collected together, as to constitute one family; that the intercourse between them and their instructers may be frequent and familiar. This renders it necessary that suitable *buildings* be provided, for the residence of the students:—we speak now of colleges in the country, the members of which are mostly gathered from a distance. In a large city, where the students reside with their parents, public rooms only are needed. This may be the case also, in professional institutions, in which the students are more advanced in age, and, therefore, do not require a minute superintendence on the part of their instructers.

Having now stated what we understand to be the proper *object* of an education at this college, viz. to lay a solid *foundation* in literature and science; we would ask permission to add a few observations on the *means* which are employed to effect this object.

In giving the course of instruction, it is intended that a due proportion be observed between *lectures*, and the exercises which are familiarly termed *recitations;* that is, examinations in a text book. The great advantage of lectures is, that while they call forth the highest efforts of the lecturer, and accelerate his advance to professional eminence; they give that light and spirit to the subject, which awaken the interest and ardor of the student. They may place before him the principles of science, in the attractive dress of living eloquence. Where instruments are to be explained, experiments performed, or specimens exhibited; they are the appropriate mode of communication. But we are far from believing, that *all* the purposes of instruction can be best answered by lectures alone. They do not always bring upon the student a pressing and definite responsibility. He may repose upon his seat, and yield a passive hearing to the lecturer, without ever calling into exercise the active powers of his own mind. This defect we endeavor to remedy, in part, by frequent examinations on the subjects of the lectures. Still it is important, that the student should have opportunities of retiring by himself, and giving a more commanding direction to his thoughts, than when listening to oral instruction. To secure his steady and earnest efforts, is the great object of the daily examinations or recitations. In these exercises, a text-book is commonly the guide. A particular portion of this is assigned for each meeting. In this way only, can the responsibility be made sufficiently definite. If it be distributed among several books upon the same subject, the diversity of statement in these, will furnish the student with an apology for want of exactness in his answers. Besides, we know of no method which will more effectually bewilder and confound the learner, on his first entrance upon a new science, than to refer him to half a dozen different authors, to be read at the same time. He will be in danger of learning nothing effectually. When he comes to be engaged in the study of his *profession*, he may find his way through the maze, and firmly establish his own opinions, by taking days or weeks for the examination of each separate point. Text-books are, therefore, not as necessary in this advanced stage of education, as in the course at college, where the time allotted to each branch is rarely more than sufficient for the learner to become familiar with its elementary principles. These, with a few exceptions, are not new and controverted points, but such as have been long settled; and they are exhibited to the best advantage, in the consistent and peculiar manner of some eminent writer.

Opportunity is given, however, to our classes, for a full investigation and discussion of particular subjects, in the written and extemporaneous *disputes*, which constitute an important part of our course of exercises. So far as the student has time to extend his inquiries, beyond the limits of his text-book, first faithfully studied, his instructer may aid him greatly, by referring to the various authors who have treated of the more important points in the lessons; and by introducing corrections, illustrations, and comments of his own. In this way, no small portion of our daily exercises become informal and extemporaneous lectures. But the business of explaining and commenting is carried to an extreme, whenever it supersedes the necessity of effort on the part of the learner. If we mistake not, some portion of the popularity of very copious oral instruction is to be set to the account of the student's satisfaction, in escaping from the demand for mental exertion. It is to secure the unceasing and strenuous exercise of the intellectual powers, that the responsibility of the student is made so constant and particular. For this purpose, our semi-annual *examinations* have been established. These, with the examination of the Seniors in July, occupy from twelve to fourteen days in a year. Each class is divided into two portions, which are examined in separate rooms at the same time, seven or eight hours a day. A committee is present on the occasion, consisting of gentlemen of education and distinction from different parts of the state. The degree of correctness with which each student answers the questions put to him in the several branches, is noted on the spot, and entered in a record, permanently kept by the Faculty. But to the instructers, the daily examinations in the recitation rooms are a more unerring test of scholarship than these public trials. The latter answer the purpose of satisfying the inquiries of strangers.

We deem it to be indispensable to a proper adjustment of our collegiate system, that there should be in it both Professors and Tutors. There is wanted, on the one hand, the experience of those who have been long resident at the institution, and on the other, the fresh and minute information of those who, having more recently mingled with the students, have a distinct recollection of their peculiar feelings, prejudices, and habits of thinking. At the head of each great division of science, it is necessary that there should be a Professor, to superintend the department, to arrange the plan of instruction, to regulate the mode of conducting it, and to teach the more important and difficult parts of the subject. But students in a college, who have just entered on the first elements of science, are not principally occupied with the more abstruse and disputable points. Their attention ought not to be solely or mainly directed to the latest discoveries. They have first to learn the principles which have been in a course of investigation, through successive ages; and have now become simplified and settled. Before arriving at regions hitherto unexplored, they must pass over the intervening cultivated ground. The Professor at the head of a department may, therefore, be greatly aided, in some parts of the course of instruction, by those who are not as deeply versed as himself in all the intricacies of the science. Indeed we doubt, whether elementary principles are always taught to the best advantage, by those whose researches have carried them so far beyond these simpler truths, that they come back to them with reluctance and distaste. Would Sir Isaac Newton have excelled all others of his day, in teaching the common rules of arithmetic? Young men have often the most ardor, in communicating familiar principles, and in removing those lighter difficulties of the pupil, which, not long since, were found lying across their own path.

In the internal police of the institution, as the students are gathered into one family, it is deemed an essential provision, that some of the officers should constitute a portion of this family; being always present with them, not only at their meals, and during the business of the day; but in the hours allotted to rest. The arrangement is such, that in our college buildings, there is no room occupied by students, which is not near to the chamber of one of the officers.

But the feature in our system which renders a considerable number of tutors indispensable, is the subdivision of our classes, and the assignment of each portion to the particular charge of one man. Each of the three junior classes is formed into two or three divisions; and each division is committed to the superintendence of a tutor. Although he is not confined to the instruction of his own division; but makes such exchanges with the other tutors as will give to each the opportunity of teaching his favorite branch; yet by meeting them in the recitation rooms two or three times every day, and by minutely inspecting their conduct on other occasions, he renders a service to the police of the institution, which could be secured in no other way. It is intended that the government should be, as much as possible, of a parental character; a government of mild and grateful influence. But the basis of this must be mutual attachment; such as can spring only from daily and peculiar intimacy. If the same teacher instructs eight or ten different divisions, in rapid succession, it will be difficult for him to feel, that he stands in a very near relation to them all. If the same student attends on a dozen different instructers, in rotation, he may respect them all; but can hardly be expected to view them with any peculiar affection.

The tutor of a division has an opportunity, which is enjoyed by no other officer of the college, of becoming intimately acquainted with the characters of his pupils. It is highly important that this knowledge should be at the command of the Faculty. By distributing our family among different individuals, minute information is acquired, which may be communicated to the Board, whenever it is called for. Upon this plan also, the *responsibility* of the several instructers is rendered far more definite, than when it rests upon the whole collectively. Each Professor is accountable for the judicious arrangement of his own department; and for the success with which it is conducted, so far as this depends on his personal efforts and talents. Each tutor is responsible, to a certain extent, for the progress and correct deportment of his division. But responsibility is little felt, when held as common stock among numbers, without a distinct appropriation to individuals. By a due proportion of professors and tutors, we may unite the advantages of experience, with ardor and activity; of profound investigation, with minute attention to elementary principles; of personal attachment and individual responsibility, with such an adjustment of the different parts of the system, as will give unity and symmetry to the whole.

The collegiate course of study, of which we have now given a summary view, we hope may be carefully distinguished from several *other* objects and plans, with which it has been too often confounded. It is far from embracing *every thing* which the student will ever have occasion to learn. The object is not to *finish* his education; but to lay the foundation, and to advance as far in rearing the superstructure, as the short period of his residence here will admit. If he acquires here a thorough knowledge of the principles of science, he may then, in a great measure, educate himself. He has, at least, been taught *how* to learn. With the aid of books, and means of observation, he may be constantly advancing in knowledge. Wherever he goes, into whatever company he falls, he has those general views, on every topic of interest, which will enable him to understand, to digest, and to form a correct opinion, on the statements and discussions which he hears. There are many things important to be known, which are not taught in colleges, because they may be learned any where. The knowledge, though indispensable, comes to us as freely, in the way of our business, as our necessary supplies of light, and air, and water.

The course of instruction which is given to the undergraduates in the college, is not designed to include *professional* studies. Our object is not to teach that which is peculiar to any one of the professions; but to lay the foundation which is common to them all. There are separate schools for medicine, law, and theology, connected with the college, as well as in various parts of the country; which are open for the reception of all who are prepared to enter upon the appropriate studies of their several professions. With these, the academical course is not intended to interfere.

But why, it may be asked, should a student waste his time upon studies which have no immediate connection with his future profession? Will chemistry enable him to plead at the bar, or conic sections qualify him for preaching, or astronomy aid him in the practice of physic? Why should not his attention be confined to the subject which is to occupy the labors of his life? In answer to this, it may be observed, that there is no science which does not contribute its aid to professional skill. "Every thing throws light upon every thing." The great object of a collegiate education, preparatory to the study of a profession, is to give that expansion and balance of the mental powers, those liberal and comprehensive views, and those fine proportions of character, which are not to be found in him whose ideas are always confined to one particular channel. When a man has entered upon the practice of his profession, the energies of his mind must be given, principally, to its appropriate duties. But if his thoughts never range on other subjects, if he never looks abroad on the ample domains of literature and science, there will be a narrowness in his habits of thinking, a peculiarity of character, which will be sure to mark him as a man of limited views and attainments. Should he be distinguished in his profession, his ignorance on other subjects, and the defects of his education, will be the more exposed to public observation. On the other hand, he who is not only eminent in professional life, but has also a mind richly stored with general knowledge, has an elevation and dignity of character, which gives him a commanding influence in society, and a widely extended sphere of usefulness. His situation enables him to diffuse the light of science among all classes of the community. Is a man to have no other object, than to obtain a *living* by professional pursuits? Has he not duties to perform to his family, to his fellow citizens, to his country; duties which require various and extensive intellectual furniture?

Professional studies are designedly excluded from the course of instruction at college, to leave room for those literary and scientific acquisitions which, if not commenced there, will, in most cases, never be made. They will not grow up spontaneously, amid the bustle of business. We are not here speaking of those giant minds which, by their native energy, break through the obstructions of a defective education, and cut their own path to distinction. These are honorable exceptions to the general law; not examples for common imitation. Franklins and Marshalls are not found in sufficient numbers to fill a college. And even Franklin would not have been what he was, if there had been no colleges in the country. When an elevated standard of education is maintained, by the higher literary institutions, men of superior powers, who have not had access to these, are stimulated to aim at a similar elevation, by their own efforts, and by aid of the light which is thus shining around them.

As our course of instruction is not intended to complete an education, in theological, medical, or legal science; neither does it include all the minute details of *mercantile*, *me-*

chanical, or *agricultural* concerns. These can never be effectually learned except in the very circumstances in which they are to be practised. The young merchant must be trained in the counting room, the mechanic, in the workshop, the farmer, in the field. But we have, on our premises, no experimental farm or retail shop; no cotton or iron manufactory; no hatter's, or silver-smith's, or coach-maker's establishment. For what purpose, then, it will be asked, are young men who are destined to these occupations, ever sent to a college? They should not be sent, as we think, with an expectation of *finishing* their education at the college; but with a view of laying a thorough foundation in the principles of science, preparatory to the study of the practical arts. As every thing cannot be learned in four years, either theory or practice must be, in a measure at least, postponed to a future opportunity. But if the scientific theory of the arts is *ever* to be acquired, it is unquestionably first in order of time. The corner stone must be laid, before the superstructure is erected. If suitable arrangements were made, the details of mercantile, mechanical, and agricultural education, might be taught at the college, to *resident graduates.* Practical skill would then be grounded upon scientific information.

The question may be asked, What is a young man fitted for, when he takes his degree? Does he come forth from the college qualified for business? We answer, no,—if he stops here. His education is begun, but not completed. Is the college to be reproached for not accomplishing that which it has never undertaken to perform? Do we complain of the mason, who has laid the foundation of a house, that he has done nothing to purpose; that he has not finished the building; that the product of his labor is not habitable; and that, therefore, there is nothing practical in what he has done? Do we say of the planter, who has raised a crop of cotton, that he has done nothing practical, because he has not given to his product the form of wearing apparel?

In education, as well as in morals, we often hear the suggestion, that principles are of no consequence, provided the practice is right. Why waste on theories, the time which is wanted for acquiring practical arts? We are aware, that some operations may be performed, by those who have little or no knowledge of the principles on which they depend. The mariner may set his sails to the wind, without understanding the laws of the decomposition of forces; the carpenter may square his frame-work, without a knowledge of Euclid's Elements; the dyer may set his colors, without being indoctrinated in the principles of chemistry. But the labors of such an one, are confined to the narrow path marked out to him by others. He needs the constant superintendence of men of more enlarged and scientific information. If he ventures beyond his prescribed rule, he works at random, with no established principles to guide him. By long continued practice, he may have attained a good degree of manual dexterity. But the arranging of plans of business, the new combinations of mechanical processes, the discoveries and improvements in the arts, must generally come from minds more highly and systematically cultivated. There is a fertility in scientific principles, of which the mere artist has no apprehension. A single general law may include a thousand or ten thousand particular cases; each one of which is as difficult to be learned or remembered, as the law which explains them all. Men of mere practical detail are wanted, in considerable numbers, to fill the subordinate places in mechanical establishments; but the higher stations require enlightened and comprehensive views.

We are far from believing that theory *alone*, should be taught in a college. It cannot be effectually taught, except in connection with practical illustrations. These are necessary in exciting an interest in theoretical instructions; and especially important in showing the application of principles. It is our aim therefore, while engaged in scientific investigations, to blend with them, as far as possible, practical illustrations and experiments. Of what use are all the sublime discoveries which have immortalized the names of Newton, Archimedes, and others; if the principles which they have unfolded, are never to be taught to those who can reduce them to practice? Why do we bestow such exalted encomiums on inventive genius, if the results of original investigations, are to be confined to a few scientific men, and not diffused among those who are engaged in the active duties of life? To bring down the principles of science to their practical application by the laboring classes, is the office of men of superior education. It is the separation of theory and practice, which has brought reproach upon both. Their union alone can elevate them to their true dignity and value. The man of science is often disposed to assume an air of superiority, when he looks upon the narrow and partial views of the mere artisan. The latter in return laughs at the practical blunders of the former. The defects in the education of both classes would be remedied, by giving them a knowledge of scientific principles, preparatory to practice.

We are aware that a thorough education is not within the reach of all. Many, for want of time and pecuniary resources, must be content with a partial course. A defective education is better than none. If a youth can afford to devote only two or three years, to a scientific and professional education, it will be proper for him to make a selection of a few of the most important branches, and give his attention exclusively to these. But this is an imperfection, arising from the necessity of the case. A partial course of study, must inevitably give a partial education.

This, we are well convinced, is far preferable to a *superficial* education. Of all the plans of instruction which have been offered to the public, that is the most preposterous, which proposes to teach almost every thing in a short time. In this way, nothing is effectually taught. The pupil is hurried over the surface so rapidly, that scarce a trace of his steps remains, when he has finished his course. What he has learned, or thinks he has learned, is just sufficient to inflate his vanity, to expose him to public observation, and to draw on him the ridicule of men of sound judgment and science. A partial education is often expedient; a superficial one, never. Whatever a young man undertakes to learn, however little it may be, he ought to learn it so effectually, that it may be of some practical use to him. If there is any way in which every thing worth knowing may be taught in four years, we are free to acknowledge, that we are not in possession of the secret.

But why, it is asked, should *all* the students in a college be required to tread in the *same steps?* Why should not each one be allowed to select those branches of study which are most to his taste, which are best adapted to his peculiar talents, and which are most nearly connected with his intended profession? To this we answer, that our prescribed course contains those subjects only which ought to be understood, as we think, by every one who aims at a thorough education. They are not the peculiarities of any profession or art. These are to be learned in the professional and practical schools. But the principles of science, are the common foundation of all high intellectual attainments. As in our primary schools, reading, writing, and arithmetic are taught to all, however different their prospects; so in a college, all should be instructed in those branches of knowledge, of which no one destined to the higher walks of life ought to be ignorant. What subject which is now studied here, could be set aside, without evidently marring the system. Not to speak particularly, in this place, of the ancient languages; who that aims at a well proportioned and superior education will remain ignorant of the elements of the various branches of the mathematics, or of history and antiquities, or of rhetoric and oratory, or natural philosophy, or astronomy, or chemistry, or mineralogy, or geology, or political economy, or mental and moral philosophy?

It is sometimes thought that a student ought not to be urged to the study of that for which he has *no taste or capacity.* But how is he to know, whether he has a taste or capacity for a science, before he has even entered upon its elementary truths? If he is really destitute of talent sufficient for these common departments of education, he is destined for some narrow sphere of action. But we are well persuaded, that our students are not so deficient in intellectual powers, as they sometimes profess to be; though they are easily made to believe, that they have no capacity for the study of that which they are told is almost wholly useless.

When a class have become familiar with the common elements of the several sciences, then is the proper time for them to *divide off* to their favorite studies. They can then make their choice from actual trial. This is now done here, to some extent, in our Junior year. The division might be commenced at an earlier period, and extended farther, provided the qualifications for admission into the college, were brought to a higher standard.

If the view which we have thus far taken of the subject is correct, it will be seen, that the object of the system of instruction at this college, is not to give a *partial* education, consisting of a few branches only; nor, on the other hand, to give a *superficial* education, containing a smattering of almost every thing; nor to *finish* the details of either a professional or practical education; but to *commence* a *thorough* course, and to carry it as far as the time of residence here will allow. It is intended to occupy, to the best advantage, the four years immediately preceding the study of a profession, or of the operations which are peculiar to the higher mercantile, manufacturing, or agricultural establishments.

As the instruction is only preparatory to a profession, the plan upon which it is conducted, is not copied from professional schools. There are important differences, arising from the different character of the two courses, and the different age at which the student enters upon them. In the professional institution, it is proper that *subjects* should be studied, rather than *text-books.* At this period, the student is engaged, not in learning the mere elements of the various sciences; but in becoming thoroughly acquainted with one great department of knowledge, to the study of which, several years are to be devoted. He ought to be allowed time to settle his own opinion on every important point, by the slow process of comparing and balancing the various and conflicting opinions of others. A much greater proportion of *lectures* is admissible, in this stage of education. The deep interest excited, by a long continued pursuit in the same field of inquiry, supersedes the necessity of the minute responsibility which is required in elementary studies. The age of the student, and the prospect of soon entering on professional practice, will commonly be sufficient to secure his assiduous application, without the coercive influence of laws and penalties.

Although the restraints in a college, are greater than in professional institutions; yet they are less than in common academies. In the latter, the student prosecutes his studies in the presence of his instructer. At the early age of ten or twelve, he needs more frequent assistance and encouragement, in the way of colloquial intercourse, than the members of a college, who, though they are young, are not children.

Our institution is not modelled exactly after the pattern of *European* universities. Difference of circumstances has rendered a different arrangement expedient. It has been the policy of most monarchical governments, to concentrate the advantages of a superior education in a few privileged places. In England, for instance, each of the ancient universities of Oxford and Cambridge, is not so much a single institution, as a large number of distinct, though contiguous colleges. But in this country, our republican habits and feelings will never allow a monopoly of literature in any one place. There must be, in the union, as many colleges, at least, as states. Nor would we complain of this arrangement as inexpedient, provided that starvation is not the consequence of a patronage so minutely divided. We anticipate no disastrous results from the multiplication of colleges, if they can only be adequately endowed. We are not without apprehensions, however, that a feeble and stinted growth of our national literature, will be the consequence of the very scanty supply of means to most of our public seminaries.

The Universities on the continent of Europe, especially in Germany, have of late gained the notice and respect of men of information in this country. They are upon a broad and liberal scale, affording very great facilities for a finished education. But we doubt whether they are models to be copied in every feature, by our American colleges. We hope at least, that this college may be spared the mortification of a ludicrous attempt to imitate them, while it is unprovided with the resources necessary to execute the purpose. The only institution in this country, which, so far as we know, has started upon the plan of the European universities, required an expenditure, before commencing operations, of more than three hundred thousand dollars; a sum far greater than Yale College has received in a century and a quarter, from the bounty of individuals and the state together. The students come to the universities in Germany at a more advanced age, and with much higher preparatory attainments, than to the colleges in this country. The period of education which is there divided into *two* portions only, one of which is spent at the gymnasium and the other at the university, is here divided into *three*, that of the grammar school, the college, and the professional school. The pupils, when they enter the university, are advanced nearly or quite as far, in literature if not in science, as our students are when graduated. The institution in Germany which corresponds most nearly to our colleges, in point of attainments, and the age of the students, is the gymnasium. The universities are mostly occupied with *professional* studies. In Halle, for example, of eleven hundred students, all except sixty are engaged in the study of Theology, Law, and Medicine. But in the United States, the professional schools are scattered over the country, and many of them are at a distance from the colleges. The different denominations of christians have their separate Theological Seminaries. Students at law are distributed in the several states, to accommodate their education to the peculiarities in the legal practice of each. If to the Theological, Medical, and Law Institutions attached to Yale College, there were added what is called in Germany a *School of Philosophy* for the higher researches of literature and science, the four departments together would constitute a university in the European sense of the term. The proper collegiate department would still have its distinct and appropriate object, that of teaching the branches preparatory to all the others. It would, in our opinion, be idle to think of adopting in the college, the regulations and plan of instruction in a university; unless the students of the former were advanced three or four years farther than at present, both in age and acquirements. Would parents in this country consent to send their sons, at the age of sixteen, to an institution in which there should not be even an attempt at discipline, farther than to preserve order in the lecture room? When the student has passed beyond the rugged and cheerless region of elementary learning, into the open and enchanting field where the great masters of science are moving onward with enthusiastic emulation; when, instead of plodding over a page of Latin or Greek, with his grammars, and dictionaries, and commentaries, he reads those languages with facility and delight; when, after taking a general survey of the extensive and diversified territories of literature, he has selected those spots for cultivation which are best adapted to his talents and taste; he may then be safely left to pursue his course, without the impulse of authoritative injunctions, or the regulation of statutes and penalties. But we question whether a college of undergraduates, unprovided with any substitute for parental control, would long be patronised in this country.

Although we do not consider the literary institutions of Europe as faultless models, to be exactly copied by our American colleges; yet we would be far from condemning every feature, in systems of instruction which have had an origin more ancient than our republican seminaries. We do not suppose that the world has learned absolutely nothing, by the experience of ages; that a branch of science, or a mode of teaching, is to be abandoned, precisely because it has stood its ground, after a trial by various nations, and through successive centuries. We believe that our colleges may derive important improvements from the universities and schools in Europe; not by blindly adopting all their measures without discrimination; but by cautiously introducing, with proper modifications, such parts of their plans as are suited to our peculiar situation and character. The first and great improvement which we wish to see made, is an elevation in the standard of attainment for admission. Until this is effected, we shall only expose ourselves to inevitable failure and ridicule, by attempting a general imitation of foreign universities.

One of the pleas frequently urged in favor of a partial education, is the alleged *want of time* for a more enlarged course. We are well aware, as we have already observed, that a thorough education cannot be begun and finished in four years. But if three years immediately preceding the age of twenty-one be allowed for the study of a profession, there is abundant time previous to this for the attainment of all which is now required for admission into the college, in addition to the course prescribed for the undergraduates. Though the limit of age for admission is fixed by our laws at fourteen, yet how often have we been pressed to dispense with the rule, in behalf of some youth who has completed his preparation at an earlier period; and who, if compelled to wait till he has attained the requisite age, "is in danger of being ruined for want of employment?" May we not expect, that this plea will be urged with still greater earnestness, when the present improved methods of instruction in the elementary and preparatory schools, are more and more accelerating the early progress of the pupil?

But suppose it should happen that the student, in consequence of commencing his studies at a later period, should be delayed a little longer, before entering upon the duties of his profession; is this a sacrifice worthy to be compared with the immense difference between the value of a limited and a thorough education? Is a young man's pushing forward into business, so indispensable to his future welfare, that rather than suspend it for a single year, he must forego all the advantage of superior intellectual discipline and attainments?

We well know that the whole population of the country can never enjoy the benefit of a thorough course of education. A large portion must be content with the very limited instruction in our primary schools. Others may be able to add to this the privilege of a few months at an academy. Others still, with higher aims and more ample means, may afford to spend two or three years, in attending upon a partial course of study, in some institution which furnishes instruction in any branch or branches selected by the pupil or his parents.

The question is then presented, whether the college shall have all the variety of classes and departments which are found in academies; or whether it shall confine itself to the single object of a well proportioned and thorough course of study. It is said that the public now demand, that the doors should be thrown open to all; that education ought to be so modified, and varied, as to adapt it to the exigencies of the country, and the prospects of different individuals; that the instruction given to those who are destined to be merchants, or manufacturers, or agriculturalists, should have a special reference to their respective professional pursuits.

The public are undoubtedly right, in demanding that there should be appropriate courses of education, accessible to all classes of youth. And we rejoice at the prospect of ample provision for this purpose, in the improvement of our academies, and the establishment of commercial high-schools, gymnasia, lycea, agricultural seminaries, &c. But do the public insist, that every college shall become a high-school, gymnasium, lyceum, and academy? Why should we interfere with these valuable institutions? Why wish to take their business out of their hands? The college has its appropriate object, and they have theirs. What advantage would be gained by attempting to blend them all in one? When in almost all our schools, and academies, and professional seminaries, the standard of education has been enlarged and elevated, is this a time for the college to *lower* its standard? Shall we fall back, and abandon the ground which, for thirty years past, we have been striving so hard to gain? Are those who are seeking only a partial education to be admitted into the college, merely for the purpose of associating its *name* with theirs? of carrying away with them a collegiate *diploma*, without incurring the fearful hazard of being over-educated? Why is a degree from a college more highly prized, than a certificate from an academy, if the former is not a voucher of a superior education? When the course of instruction in the one, is reduced to the level of that in the other; to be graduated at either, will be equally honorable. What is the characteristic difference between a college and an academy? Not that the former teaches more branches than the latter. There are many academies in the country, whose scheme of studies, at least upon paper, is more various than that of the colleges. But while an academy teaches a little of every thing, the college, by directing its efforts to one uniform course, aims at doing its work with greater precision, and economy of time; just as the merchant who deals in a single class of commodities, or a manufacturer who produces but one kind of fabrics, executes his business more perfectly, than he whose attention and skill are divided among a multitude of objects.

If our treasury were overflowing, if we had a *surplus fund*, requiring us to look out for some new object on which to expend it, there might perhaps be no harm in establishing a department for a brief and rapid course of study, so far connected with the college, as to be under the superintendence of the same board of trust. But it ought to be as distinct from the four classes of undergraduates, as is the medical or law school. All the means which are now applied to the proper collegiate department, are barely sufficient, or rather are insufficient, for the object in view. No portion of our resources, or strength, or labor, can be diverted to other purposes, without impairing the education which we are attempting to give. A London university, commencing with a capital of several hundred thousand dollars, and aiming to provide a system of instruction for the youth in a city whose population is more than a million, may well establish its higher and inferior courses, its scientific and practical departments, its professional, mercantile, and mechanical institutions. But shall a college, with an income of two or three thousand a year from funds, affect to be at once a London university? Should we *ever* become such an institution, our present undergraduate course, ought still to constitute one distinct branch of the complicated system of arrangements.

But might we not, by making the college more accessible to different descriptions of persons, enlarge our *numbers*, and in that way, increase our income? This might be the operation of the measure, for a very short time, while a degree from the college should retain its present value in public estimation; a value depending entirely upon the character of the education which we give. But the moment it is understood that the institution has descended to an inferior standard of attainment, its reputation will sink to a corresponding level. After we shall have become a college in *name only*, and in reality nothing more than an academy; or half college, and half academy; what will induce parents in various and distant parts of the country, to send us their sons, when they have academies enough in their own neighborhood? There is no magical influence in an act of incorporation, to give celebrity to a literary institution, which does not command respect for itself, by the elevated rank of its education. When the college has lost its hold on the public confidence, by depressing its standard of merit, by substituting a partial, for a thorough education, we may expect that it will be deserted by that class of persons who have hitherto been drawn here by high expectations and purposes. Even if we should *not* immediately suffer in point of *numbers*, yet we shall exchange the best portion of our students, for others of inferior aims and attainments.

As long as we can maintain an elevated character, we need be under no apprehension with respect to numbers. Without character, it will be in vain to think of retaining them. It is a hazardous experiment, to act upon the plan of gaining numbers first, and character afterwards.

We are sensible there is great imperfection in the *execution* of the purpose to give a thorough course of instruction. The observations which we have made on this subject, relate rather to what we would *wish* to see effected, than to what we profess to have actually accomplished. Numerous and formidable difficulties are to be perpetually encountered. One of the principal of these, is the call which is so frequently made upon us, to admit students into the college with *defective preparation*. Parents are little aware to what embarrassments and injury they are subjecting their sons, by urging them forward to a situation for which they are not properly qualified. Of those who are barely admitted, one and another is, from time to time, dropped off from the class. Here and there one, after making his way, with much perplexity and mortification, through the four years, just obtains a degree at last; which is nearly all the benefit that he derives from his residence here. Whereas, if he had come to us well prepared, he might have held a respectable rank in his class, and acquired a substantial education.

Another serious difficulty with which we have to contend, is the impression made on the minds of a portion of our students, from one quarter and another, that the study of any thing for which they have not an instinctive relish, or which requires vigorous and continued effort, or which is not immediately connected with their intended professional pursuits, is of no practical utility. They of course remain ignorant of that which they think not worth the learning. We are concerned to find, that not only students, but their parents also, seem frequently more solicitous for the *name* of an education, than the substance.

The difficulties with which we are now struggling, we fear would be increased, rather than diminished, by attempting to unite different plans of education. It is far from being our intention to dictate to *other* colleges a system to be adopted by them. There may be good and sufficient reasons why some of them should introduce a partial course of instruction. We are not sure, that the demand for thorough education is, at present, sufficient to fill all the colleges in the United States, with students who will be satisfied with nothing short of high and solid attainments. But it is to be hoped that, at no very distant period, they will be able to come up to this elevated ground, and leave the business of second-rate education to the inferior seminaries.

The competition of colleges may advance the interests of literature: if it is a competition for *excellence*, rather than for numbers; if each aims to surpass the others, not in an imposing display, but in the substantial value of its education. When the rivalry becomes a mere scramble for numbers, a dexterous arrangement of measures in beating up for recruits, the standard of attainment will sink lower and lower, till the colleges are brought to a level with common academies. Does it become the patrons and guardians of sound learning, to yield to this depressing and deteriorating influence? Our country has ample resources for furnishing to great numbers the means of a thorough education. At the same time, peculiar temptations are here presented to our youth, to induce them to rest satisfied with a partial and superficial course of study. In Europe, the competition among literary men is so pressing, that those of moderate attainments can have little hope of success. But in this country, the field of enterprise is so wide, the demand for even ordinary learning is so urgent, and the occupations which yield a competent living are so numerous and accessible; that a young man of a very limited stock of knowledge, if he have a good share of self-confidence, and a driving, bustling spirit, can push himself forward into notice and employment. He may even mount the steps which lead to office and popular applause. If he fail to enlighten his countrymen by his intellectual superiority, he may at least attract their gaze by the tinsel of his literary ornaments. This is the allurement to a hurried and superficial education. We have abundant supplies of this Lombardy-poplar growth ; slender, frail, and blighted. We should like to see more of the stately elm ; striking deep its roots, lifting its head slowly to the skies, spreading wide its grateful shade, and growing more and more venerable with years. There are few instances of a more improvident expenditure of time and money, than that which is wasted upon a superficial education. The parent often labors hard to furnish his son with the means of acquiring that which is of no substantial value ; when with a little more time, and a small additional expense, a foundation might have been effectually laid, for high literary excellence, and professional distinction.

Our duty to our country demands of us an effort to provide the means of a thorough education. There is perhaps no nation whose interests would be more deeply affected, by a substitution of superficial for solid learning. The universal diffusion of the common branches of knowledge, renders it necessary that those who aspire to literary eminence should ascend to very elevated ground. They must take their position on a summit which towers above the height of surrounding ranges of hills. In the midst of so enlightened a population, can he be distinguished, whose education has scarcely given him more enlarged views, than he might acquire, by conversation in stages and steam boats ; or the reading of newspapers, and a volume or two of elegant extracts ?

The unexampled multiplication of schools and academies in this country, requires that colleges should aim at a high standard of literary excellence. The conviction is almost universal, that the former, as well as the latter, admit of great improvements. But who are to make these improvements, and give character and tone to our systems of instruction, if there are few men of thorough education in the country ? He who is to arrange an extensive scheme of measures, ought himself to stand on an eminence, from which he can command a view of the whole field of operation. Superficial learning in our higher seminaries, will inevitably extend its influence to the inferior schools. If the fountains are shallow and turbid, the streams cannot be abundant and pure. Schools and colleges are not *rival* institutions. The success of each is essential to the prosperity of the other.

Our republican form of government renders it highly important, that great numbers should enjoy the advantage of a thorough education. On the Eastern continent, the *few* who are destined to particular departments in political life, may be educated for the purpose; while the mass of the people are left in comparative ignorance. But in this country, where offices are accessible to all who are qualified for them, superior intellectual attainments ought not to be confined to any description of persons. *Merchants*, *manufacturers*, and *farmers*, as well as professional gentlemen, take their places in our public councils. A thorough education ought therefore to be extended to all these classes. It is not sufficient that they be men of sound judgment, who can decide correctly, and give a silent vote, on great national questions. Their influence upon the minds of others is needed; an influence to be produced by extent of knowledge, and the force of eloquence. Ought the speaking in our deliberative assemblies to be confined to a single profession? If it is knowledge, which gives us the command of physical agents and instruments, much more is it that which enables us to control the combinations of moral and political machinery.

Young men intended for active employments ought not to be excluded from the colleges, merely on the ground that the course of study is not specially adapted to their pursuits. This principle would exclude those also who are intended for the professions. In either case, the object of the undergraduate course, is not to finish a preparation for business; but to impart that various and general knowledge, which will improve, and elevate, and adorn any occupation. Can merchants, manufacturers, and agriculturists, derive no benefit from high intellectual culture? They are the very classes which, from their situation and business, have the best opportunities for reducing the principles of science to their practical applications. The large estates which the tide of prosperity in our country is so rapidly accumulating, will fall mostly into their hands. Is it not desirable that they should be men of superior education, of large and liberal views, of those solid and elegant attainments, which will raise them to a higher distinction, than the mere possession of property; which will not allow them to hoard their treasures, or waste them in senseless extravagance; which will enable them to adorn society by their learning, to move in the more intelligent circles with dignity, and to make such an application of their wealth, as will be most honorable to themselves, and most beneficial to their country?

The active, enterprising character of our population, renders it highly important, that this bustle and energy should be directed by sound intelligence, the result of deep thought and early discipline. The greater the impulse to action, the greater is the need of wise and skilful guidance. When nearly all the ship's crew are aloft, setting the topsails, and catching the breezes, it is necessary there should be a steady hand at helm. Light and moderate learning is but poorly fitted to direct the energies of a nation, so widely extended, so intelligent, so powerful in resources, so rapidly advancing in population, strength, and opulence. Where a free government gives full liberty to the human intellect to expand and operate, education should be proportionably liberal and ample. When even our mountains, and rivers, and lakes, are upon a scale which seems to denote, that we are destined to be a great and mighty nation, shall our literature be feeble, and scanty, and superficial?

PART II.

Containing extracts from that part of the report of the faculty in which the resolution of the corporation is more particularly considered.

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By a liberal education, it is believed, has been generally understood, such a course of discipline in the arts and sciences, as is best calculated, at the same time, both to strengthen and enlarge the faculties of the mind, and to familiarize it with the leading principles of the great objects of human investigation and knowledge. A liberal, is obviously distinct from a professional, education. The former is conversant with those topics, an acquaintance with which is necessary or convenient, in any situation of life; the latter, with those which qualify the individual for a particular station, business or employment. The former is antecedent in time; the latter rests upon the former as its most appropriate foundation. A liberal education is fitted to occupy the mind, while its powers are opening and enlarging; a professional education requires an understanding already cultivated by study, and prepared by exercise for methodical and persevering efforts.

Such seem to be the views, on which the system of a collegiate education is founded. It has been believed, that there are certain common subjects of knowledge, about which all men ought to be informed, who are best educated; who are prepared to mingle to the best advantage with persons of different tastes, ages and pursuits; and to enter with the best prospects of success, on the details of professional study and practice. As this education, which is called liberal, was originally founded on existing objects of literary interest and pursuit, it has always had reference to such objects, and has varied with the varying state of knowledge. What, therefore, at one time, has been held in little estimation, and has hardly found a place in a course of liberal instruction, has, under other circumstances, risen into repute, and received a proportional share of attention. It is not now the inquiry, whether the changes in the collegiate course have been sufficiently great and frequent;—it is enough for the present purpose, to state the fact of such changes, and to admit their propriety.

An education, then, to be liberal, should have reference to the principal branches of knowledge; and as knowledge varies, education should vary with it.

The subject of inquiry now presented, is, whether the plan of instruction pursued in Yale College, is sufficiently accommodated to the present state of literature and science; and, especially, whether such a change is demanded as would leave out of this plan the study of the Greek and Roman classics, and make an acquaintance with ancient literature no longer necessary for a degree in the liberal arts. Before considering this topic directly, it may be useful to premise a few remarks on another branch of liberal education, in order more clearly to exhibit the kind of objections which are often thrown out, some against one part, and some against another, of the whole course of collegiate study;—and to make more apparent the limited and inadequate views of those who urge them.

The usefulness of mathematical learning is generally admitted; and few persons, perhaps none, would consider that course of education liberal, from which the mathematics are wholly excluded. At least, the study of the mathematics is allowed a prominent place in those institutions in which, what is called a practical education is the professed object aimed at; and from which the ancient languages, on the ground of their being of little or no practical utility, are in part or wholly excluded. If it is asked, on what grounds the pretensions of mathematical learning rest? the reply is at hand. The study of the mathematics, by the consent of the ablest men who have been conversant with the business of instruction, is especially adapted to sharpen the intellect, to strengthen the faculty of reason, and to induce a general habit of mind favorable to the discovery of truth and the detection of error. Mathematical science, furthermore, lies at the foundation of most of the practical sciences; or affords valuable aid in illustrating their principles, and in applying them to the purposes of life. It forms the best preparation for pursuing the study of physics in all its branches; and is not without its use, at least in its indirect influence, in most of our reasoning on other subjects.

But here it is sometimes objected, that though much of this may be true, still mathematical knowledge, to most students is of little practical use. The plain rules of arithmetic, it is said, are all which most men ever find occasion to apply; and if to these rules is added a knowledge of book-keeping, few, indeed, feel the want of more extensive information in this department of knowledge. Why, it is asked, should a student be compelled to devote years to the acquisition of a species of knowledge, which is useful only, as it enables him to advance to the study of navigation, surveying, astronomy, and other sciences, into which mathematical principles largely enter; when he has no wish or expectation to engage practically in either of these sciences;—and will probably from his distaste for the whole subject, forget in a few years, what he has learned with so great labor? If a man occupied in divinity, law or physic, wishes to know any principle in navigation, let him inquire, says the objector, of some one whose business it is to understand this science. If he wishes a substance analyzed, let him apply to the professed chemist; if he wishes to know the name of some mineral, its properties, or its use, let him ask the mineralogist, who from his love of this science, has made himself familiar with the numerous facts and details which it embraces; and who, by his superior knowledge in his profession, finds actual employment within its precincts. If it is important, that he should know the times of the rising and setting of the sun and moon, the time, quantity, or duration of an eclipse, let him purchase an almanac, which is a much shorter way to the whole of this knowledge, than to determine even one of these particulars by his own calculation. Let those study the sciences, and those only, who have a taste for them, and who expect to pursue at least some one science for a livelihood. If the knowledge of any science is of use, the demand for this knowledge will insure not only its existence, but its prevalence to the exact extent needed; and every thing beyond this is not only superfluous but injurious. Those act in opposition to the plainest principles of political economy, who manufacture for the market an unsaleable article. If wares are not wanted, who does not see, that there will be a glut? and the manufacturer, who shall persist in furnishing them, will work his own ruin: that is, institutions, in which mathematics are taught beyond their actual application to use, will of necessity be deserted by the public.

But notwithstanding all these difficulties and objections, the knowledge in question is still practical; not in the narrow view of it which the objector takes, but in a sense higher and wider, and which it may be useful briefly to explain. The student, who has laid up a fund of mathematical knowledge, and has extended his inquiries to those sciences which depend on mathematical principles, though he is employed in the practical application of no science, yet is brought into an important relation to those who are so employed, and experiences from this relation the most important benefits. He is able to judge of the pursuits of others, to estimate the value of these pursuits, to understand the progress of science, and to feel an interest in the occupations of a large portion of mankind. Whether his own station in life is public or private, whether he engages in a professional career, or is called upon to discharge the duties of a magistrate, the occasions for employing his knowledge are innumerable. Granting, that he loses from his memory, many or most of the details of the sciences, he still knows where to apply for information, and how to direct his inquiries; and is able to judge correctly of the talents and pretensions of those who are prominent in any one department, and whom he may wish to employ in the accomplishment of actual business. He is acquainted with the region where he is, acts more understandingly in what he undertakes, and is found, in consequence of his knowledge, to be, in all his transactions, a more practical man. The student likewise, by familiarizing himself with the general principles of the sciences, prepares himself for pursuing, to whatever extent he chooses, any one branch, for which he finds himself to possess talents and inclination. Educated in this way, besides the advantages of mental discipline which have been already mentioned, he enlarges the circle of his thoughts, finds in his superior information, new means of benefiting or influencing others, and his mind is thus far liberalized by liberal knowledge.

It is on the same general grounds, that the use and necessity of classical literature in a liberal education may be defended. That this study occupies, at the present time, an important place among literary pursuits, both in Europe and America, will not be denied. In the British Islands, in France, Germany, Italy, and, indeed, in every country of Europe in which literature has acquired distinction and importance, the Greek and Roman classics constitute an essential part of a liberal education. In some countries, classical studies are reviving from a temporary depression; in others, where no such depression has been experienced, they are pursued with increased ardor; and in none, are they known to be declining in public estimation. There may be more variety of opinion than formerly, as to the use of classical learning in certain departments of life; but the conviction of its necessity in the highest education, that which has any claim or pretence to be denominated liberal, is not known to have sustained any considerable change. The literature of every country of Europe is founded more or less on classical literature, and derives from this source its most important illustrations. This is evident not only from such works as have long since appeared, and which form the standard literature of modern times, but from those most recently published, and even from the periodical works of the day. Classical learning is interwoven with every literary discussion. The *fact* only is here insisted on, and this is undeniable. Whoever, then, without a preparation in classical literature, engages in any literary investigation, or undertakes to discuss any literary topic, or associates with those who in any country of Europe, or in this country, are acknowledged to be men of liberal acquirements, immediately feels a deficiency in his education, and is convinced that he is destitute of an important part of practical learning. If scholars, then, are to be prepared to act in the literary world as it in fact exists, classical literature, from considerations purely practical, should form an important part of their early discipline.

But the claims of classical learning are not limited to this single view. It may be defended not only as a necessary branch of education, in the present state of the world, but on the ground of its distinct and independent merits. Familiarity with the Greek and Roman writers is especially adapted to form the taste, and to discipline the mind, both in thought and diction, to the relish of what is elevated, chaste, and simple. The compositions which these writers have left us, both in prose and verse, whether considered in reference to structure, style, modes of illustration, or general execution, approach nearer than any others to what the human mind, when thoroughly informed and disciplined, of course approves; and constitute, what it is most desirable to possess, a standard for determining literary merit. This excellence of the ancient classic writers is, indeed, doubted or denied;—and it becomes, therefore, necessary to adduce such proof of it as the subject admits.

The case here to be considered is not unaccompanied by analogies. In the range of human improvement, there are other facts nearly allied, both in their character and circumstances, to this now asserted, which afford it very powerful support. Architecture and sculpture, in their most approved forms, not only had their origin, but received their perfection in Greece. These arts may have been, in certain respects, modified in the progress of time; changes may have been introduced to accommodate their productions to the necessities and manners of a later age; yet the original works of Grecian genius are the models by which artists, even at the present time, direct their labors; the standards by which, in a great measure, their merits are determined. It is in vain to pretend that this is the effect of prejudice, the bias of early impressions, and the undue veneration of antiquity. The statuary, in modelling a head or an arm, has nature always in view; yet he refers notwithstanding to the remains of Grecian art as his best guides, the surest interpreters of nature itself. His work is not imitation; it is a nearer approach to perfection through the skill derived from the contemplation and study of superior excellence. In architecture, the eye of one least conversant with antiquity is struck with the simplicity and just proportions of Grecian models; and these first impressions are strengthened by observation and reflection. Time, which brings to light so many defects, and suggests so many improvements in most of the discoveries of men, has added its sanction to the perfection, which followed the efforts of the early cultivators of architectural science.

If, then, sculpture and architecture, after the revolution of so many centuries, still derive aid from the remains of ancient skill, it ought not to excite surprise, that in other departments of taste, antiquity should exhibit the same excellence; we need not wonder, that in poetry and eloquence, it should have likewise left specimens, worthy to become patterns for succeeding ages. That this superiority belongs to ancient literature, is proved by the only proper evidence, the voice of men of letters in every country where the classics have been studied, and where a correct taste has prevailed. It is unnecessary here to cite authorities. The literature of Europe attests the fact. Hardly a question can be named where the practical decision of mankind has been more absolute.

But the study of the classics is useful, not only as it lays the foundations of a correct taste, and furnishes the student with those elementary ideas which are found in the literature of modern times, and which he no where so well acquires as in their original sources;—but also as the study itself forms the most effectual discipline of the mental faculties. This is a topic so often insisted on, that little need be said of it here. It must be obvious to the most cursory observer, that the classics afford materials to exercise talent of every degree, from the first opening of the youthful intellect to the period of its highest maturity. The range of classical study extends from the elements of language, to the most difficult questions arising from literary research and criticism. Every faculty of the mind is employed; not only the memory, judgment, and reasoning powers, but the taste and fancy are occupied and improved.

Classical discipline, likewise, forms the best preparation for professional study. The interpretation of language, and its correct use, are no where more important, than in the professions of divinity and law. But in a course of classical education, every step familiarizes the mind with the structure of language, and the meaning of words and phrases. In researches of a historical nature, and many such occur in the professions, a knowledge, especially of the Latin language, is often indispensable. The use of a thorough knowledge of Greek to a theologian, no one will deny. It is admitted that instances may be found of distinguished success in these professions, where the advantages of a classical education were not enjoyed;—but success of this kind proves only that talents may sometimes force their way to eminence through powerful obstacles. In settling a plan of education, the inquiry should be, not what some men of uncommon endowments have done, but what most men find necessary. Even in cases of extraordinary success, such as have been now alluded to, the want of classical knowledge has been often felt and lamented.

In the profession of medicine, the knowledge of the Greek and Latin languages is less necessary now than formerly; but even at the present time it may be doubted, whether the facilities which classical learning affords for understanding and rendering familiar the terms of science, do not more than counterbalance the time and labor requisite for obtaining this learning. Besides, a physician, who would thoroughly investigate the history of his profession, will find a knowledge of the ancient languages, essential to his object. In all the professions, likewise, a knowledge of general literature is of high importance as a qualification for extensive intercourse with mankind. The formality of the professional character, where the course of reading and thinking is confined to one channel, has often been remarked. The mere divine, the mere lawyer, or the mere physician, however well informed he may be in his particular profession, has less chance of success, than if his early education had been of a more liberal character.

For these very obvious advantages, which now attend the study of classical literature in the college, the course of study which, it is understood, would be proposed as a substitute, promises but few and partial equivalents. Instead of the poems of Homer, which have had so extensive and important an influence on the heroic poetry of all succeeding times, and which, it cannot be denied, are constantly appealed to as establishing many of the most important canons of criticism, we are presented in several new courses, with the Henriade of Voltaire; and the History of Charles XII. of the same author, in place of the historical writings of Livy and Tacitus. This is a specimen of the improvements in education which are the occasion of so much boasting; an example of a change to render knowledge more practical and popular. But in what sense, so far as an acquaintance with the rules of taste, and a familiarity with those general principles by which literary merit is judged, is a knowledge of the Henriade more practical than a knowledge of the Iliad? How is the former to qualify its possesser to act in the literary world in a manner more advantageous than the latter? Do we find that by critics of eminence, Voltaire as a poet has a higher place assigned him than Homer, or that they consider him as a model to be more carefully studied and imitated? Or to make the inquiry more general; in order to understand the true spirit and genius of English literature,—which is of the greatest practical use, the literature of France, or the literature of Greece and Rome? The most superficial acquaintance with the principal authors in our language, is sufficient to excite wonder, that such questions should be seriously asked.

If the new course proposed, considered as an introduction to a knowledge of general literature, is altogether inferior to the old, and far less practical in its character,—it will be found not less deficient for the purposes of mental discipline. To acquire the knowledge of any of the modern languages of Europe, is chiefly an effort of memory. The general structure of these languages is much the same as that of our own. The few idiomatical differences, are made familiar with little labor; nor is there the same necessity of accurate comparison and discrimination, as in studying the classic writers of Greece and Rome. To establish this truth, let a page of Voltaire be compared with a page of Tacitus.

Nor is this course of education which excludes ancient literature, less objectionable as the foundation of professional study. The student who has limited himself to French, Italian and Spanish, is very imperfectly prepared to commence a course of either divinity or law. He knows less of the literature of his own country, than if he had been educated in the old method; the faculties of his mind have been brought into less vigorous exercise; and the sources of the knowledge which he is now to acquire, are less accessible. If it is said, that the course of exclusive modern literature is intended for those who are not designed for professional life; the reply is, that the number of those who obtain a liberal education, without at first deciding whether they shall be professional men or not, is far from inconsiderable. Many, who originally suppose their minds determined on this subject, alter their determinations from circumstances, which they could not foresee. Adopt the course proposed, and many would enter upon it, merely from its novelty; more from a persuasion, that it would be attended with less labor; and the consequence would be, that the college, so far as this cause should operate, would be the means of lowering the professional character of our country. But here it will be asked, Is the literature of the modern nations of Europe to form no part of a course of liberal education? Is not modern literature a subject of discussion as well as ancient? Undoubtedly it is; and facilities for acquiring the more popular languages of Europe should be afforded in our public institutions. The claims of the modern languages are questioned only when they are proposed as substitutes for the ancient, not when they are recommended on their own merits. If modern literature is valuable, it should be studied in that way, which leads most directly to a thorough understanding of it; and this way lies through the literature of the ancients. If the languages and literature of Italy, France and Spain, beyond what is merely superficial, is an object with the student, they should be acquired through the Latin; nor is there reason to doubt, so far as experience affords the means of judging, that this is the most expeditious mode of acquiring a familiarity with the languages in question. To begin with the modern languages in a course of education, is to reverse the order of nature.

Modern languages, with most of our students, are studied, and will continue to be studied, as an accomplishment, rather than as a necessary acquisition. Those likewise who spend time in learning to speak the modern languages, soon lose their knowledge, unless they live where these languages are in constant use; nor can there be a doubt, that students do as generally neglect their French, Italian and Spanish, in after life, except when these languages are retained by the course of business, as they neglect their Latin and Greek. This is especially true in professional life; where the demand for a knowledge of the modern languages, in comparison with the ancient, is altogether inconsiderable. To suppose the modern languages more practical than the ancient, to the great body of our students, because the former are now spoken in some parts of the world, is an obvious fallacy. The proper question is,—what course of discipline affords the best mental culture, leads to the most thorough knowledge of our own literature, and lays the best foundation for professional study. The ancient languages have here a decided advantage. If the elements of modern languages are acquired by our students in connection with the established collegiate course, and abundant facilities for this purpose, have for a long time, been afforded, further acquisitions will be easily made, where circumstances render them important and useful. From the graduates of this college, who have visited Europe, complaints have sometimes been heard, that their classical attainments were too small for the literature of the old world; but none are recollected to have expressed regret, that they had cultivated ancient learning while here, however much time they might have devoted to this subject. On the contrary, those who have excelled in classical literature, and have likewise acquired a competent knowledge of some one modern European language besides the English, have found themselves the best qualified to make a full use of their new advantages. Deficiencies in modern literature are easily and rapidly supplied, where the mind has had a proper previous discipline; deficiencies in ancient literature are supplied tardily, and in most instances, imperfectly.

A sort of middle course has, indeed, been proposed by some, by which students for admission to college are required to have some elementary knowledge of Latin and Greek; but after they are once admitted, the ancient languages are to be thrown aside, and modern literature alone attended to. Or students, on their admission to college, are to have their option, whether to pursue this new course, or the one long established. Both parties start in this case, it is said, from the same point; and like travellers to the capital of the Union, take different roads, but at last, that is, when they graduate, all come together again, before their final separation to the various occupations of life.

But this project is liable to the objection, that students who should discontinue the study of Latin and Greek on their admission to college, would know just enough of these languages to undervalue and hate them. These would be the persons to proclaim on every side the worthlessness of ancient literature; that they had learned the Latin and Greek languages, and had derived no benefit from them; that they had even forgotten all they ever knew. All which, with the exception of their over estimate of their former knowledge, would be, as respects themselves, the exact truth. Besides, these persons, thus educated for the purposes of real life, would in many instances after their graduating, find it practically convenient to set up as instructors in these worthless languages. With few, or rather no qualifications, for the office they would assume, the cause of instruction must necessarily suffer under their management. The college, if ancient learning is to be retained at all as a part of its course, as it must rely on its graduates to instruct in the preparatory schools, would be the first sufferer from this improved system; and thus be made to minister to its own destruction.

It is besides a matter of some curiosity to know, what is intended, by the final union of students who take these different paths. That they would find, at the end of their course, that they had all acquired the same education, is certainly not the meaning; as this contradicts the original hypothesis. The only union manifest is this, that they would be all admitted to a degree. They would unite in receiving their diplomas. If to obtain the honors of college, as they are called, was the great object of an education, this improvement in the old collegiate course might be considered as real. But if the substance and not the shadow, if the thing signified and not the sign only are aimed at,—the question is still open for consideration,—whether these different roads would not lead those who travel them, to entirely different regions.

Manifest, however, as is the fallacy of substituting a diploma for an education, this scheme might not improbably be approved of by a portion of the community; and a temporary popularity follow the change. Nor is there reason to believe, that this is the limit of improvements on the old modes of literary travelling.

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Such, then, being the value of ancient literature, both as respects the general estimation in which it is held in the literary world, and its intrinsic merits,—if the college should confer degrees upon students for their attainments in modern literature only, it would be to declare *that* to be a liberal education, which the world will not acknowledge to deserve the name;—and which those who shall receive degrees in this way, will soon find, is not what it is called. A liberal education, whatever course the college should adopt, would without doubt continue to be, what it long has been. Ancient literature is too deeply inwrought into the whole system of the modern literature of Europe to be so easily laid aside.

The college ought not to presume upon its influence, nor to set itself up in any manner as a dictator. If it should pursue a course very different from that which the present state of literature demands; if it should confer its honors according to a rule which is not sanctioned by literary men, the faculty see nothing to expect for favoring such innovations, but that they will be considered visionaries in education, ignorant of its true design and objects, and unfit for their places. The ultimate consequence, it is not difficult to predict. The college would be distrusted by the public, and its reputation would be irrecoverably lost.

Another plan for improving on the collegiate system, is,—to confer degrees on those only who have finished the present established course,—but to allow other students, who do not aim at the honors of the college, to attend on the instruction of the classes as far as they shall choose. This scheme, it is supposed, has a manifest superiority over all others. It will satisfy the wishes of those who are pleased with the old system, and open the advantages of the college to such as from their circumstances wish for a partial education. That an education may be partial, and still useful, is not denied. Such an education must, after all, be that which is acquired by the great body of the community. That the means of such an education should be abundant; that the encouragement to it should be every way adequate to the object, all acknowledge. The only question is, whether two schemes of education, so diverse, can be properly united in the same seminary. The objections to such an union in this college are obvious and great.

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In colleges differently constituted from this, such a union might be unobjectionable; here, certainly, both classes of students would only injure each other.

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But with respect to all proposals of this kind, the inquiry should be, is there such a demand on the part of the public for these changes as to make it imperative on the college to adopt them in any of the forms in which they have been presented? That there are complaints of the old system of collegiate education in some of the public journals; that individuals are clamorous on this subject, and consider every thing old as of course wrong, and every thing new as of course right, is admitted. But that the great body of the supporters of this college, those to whom it is to look for countenance and patronage, are to be numbered in the ranks of these innovators, no reason appears for believing. By persevering in the course of conferring degrees, on those only who have been thoroughly disciplined in both ancient and modern learning, the college has much to expect, and nothing to fear: but by deserting the high-road which it has so long travelled, and wandering in lanes and bye-paths, it would trifle with its prosperity, and put at hazard the very means of its support and existence.

After these general remarks on the question which has been proposed, it may not be thought irrelevant to the subject, to notice briefly a topic, which, of late, is almost invariably introduced whenever the present state of our colleges is discussed. Allusion is here made to the charge reiterated in so many forms, that colleges, even in this country, are places where abuses are cherished; where antiquated notions and habits are retained long after they are discarded by all the world besides; and especially, that, here all improvement is opposed, and as far as possible excluded.

One writer, who may be thought to speak authoritatively on this point, says, "the course of public instruction remains, after the lapse of two centuries, nearly the same." "The system of European education has been transferred, with little variation, to our American colleges. And, whatever may be the state of things there, I hesitate not to say, that in this country, important improvements are necessary." Another writer, after stating that our systems of education were derived from the European institutions, and that, at first, they were ill adapted to the peculiar character of this country, goes on to say, "The same systems, however, with slight alterations, have been brought down to the present day, and now reign in our public seminaries,—while the general circumstances of the country have become totally changed." And again, "Is it wise to endeavor to qualify a youth for exertion and usefulness in the United States, by methods designed to form ecclesiastics under the monarchies of the old world?"

From such representations as these, the impression is left on the minds of many, that our colleges are, in every important respect, what they were when originally instituted; that the last persons to make improvements in education, are those to whom education is a business; and particularly, that those who instruct in colleges, surpass all others in stupidity, and are content to be forever grinding in the same mill, with their eyes fixed on the path in which they are constantly moving the same round. It is unnecessary here to go into a general defence of our colleges,—a few statements respecting this college will be sufficient. What Yale College was in its infancy we are told, in part, in Chandler's Life of Dr. Johnson, the first President of King's College, New-York. Dr. Johnson graduated in 1714, and his biographer probably derived his information respecting the college, as it was at that time, from Dr. Johnson himself. "For many years," says Dr. Chandler, "the utmost that was generally attempted, at the college, in classical learning, was to construe five or six of Tully's orations, as many books of Virgil, and part only of the Greek Testament, with some chapters of the Hebrew Psalter. Common arithmetic, and a little surveying, were the *ne plus ultra* of mathematical acquirements. The logic, metaphysics, and ethics that were then taught, were entangled in the scholastic cobwebs of a few paltry systems, that would now be laid by as proper food for worms. Indeed, at the time when Mr. Johnson took his Bachelor's degree, the students had heard of a certain new and strange philosophy, that was in vogue in England, and the names of Descartes, Boyle, Locke, and Newton, had reached them; but they were not suffered to think that any valuable improvements were to be expected from philosophical innovations, &c."

From the peculiar prejudices of this writer, some of his representations are to be received with important deductions; but that his account of the college, at the time Dr. Johnson was an undergraduate, so far as it respects the extent of the course of study, is substantially correct, appears from other evidence altogether independent. Dr. Benjamin Lord of Norwich in this state, in the year 1784, being then ninety years old, wrote to President Stiles an account of the college, as it was when he was a student. Dr. Lord graduated the same year as Dr. Johnson, that is, in 1714. In his letter he says, "Books of the languages and sciences recited in my time, were Tully and Virgil, Burgersdicius' and Ramus' Logic, Pierson's Manuscript of Physics, &c. We recited the Greek Testament, knew not Homer, &c.; recited the Psalms in Hebrew. We recited Ames' Medulla on Saturdays, and also his cases of Conscience sometimes. As for Mathematics, we studied and recited little more than the rudiments, some of the plainest things in them ;—our advantages in that day, were too low, for any to rise high in any branch of literature," &c. Surely it will not be maintained by any one, who has the least knowledge of the subject, and who has no sinister object in view, that from 1714 to 1828, only "slight alterations" have been made in the system of education in this college. So far is this from being true, that new departments have been added, and the course of languages, mathematics, physics, and indeed every branch, has been greatly enlarged. It is now impossible to trace the successive changes with exactness. It is obviously implied in the language of Dr. Chandler, who was himself a graduate of the college, that great improvements had been made even in his time. It is well known, that the study of Mathematics and Natural Philosophy, was greatly advanced during the Presidency of President Clap. Attention to English composition and oratory was much increased about the year 1770, and in subsequent years. Within the last thirty years, the changes which have been introduced, both into the course of study, and the mode of instruction, are within the recollection of members of the faculty and of the corporation. By what appears to be a wise provision in our laws, the selection of text-books, the mode of instruction, the course of the examinations, and many of the most important details in the practical concerns of the college, are left to the judgment and discretion of the faculty; the corporation having at all times the right of revision. No question has engaged the attention of the faculty more constantly, than how the course of education in the college might be improved, and rendered more practically useful. Free communications have at all times been held between the faculty and the corporation, on subjects connected with the instruction of the college. When the aid of the corporation has been thought necessary, it has been asked; and by this course of proceeding, the interests of the institution have been regularly advanced. No remark is more frequently made by those, who visit the college after the absence of some years, than that changes have been made for the better; and those who make the fullest investigation, are the most ready to approve what they find. The charge, therefore, that the college is stationary, that no efforts are made to accommodate it to the wants of the age, that all exertions are for the purpose of perpetuating abuses, and that the college is much the same as it was at the time of its foundation, are wholly gratuitous. The changes in the country, during the last century, have not been greater than the changes in the college. These remarks have been limited to Yale College, as its history is here best known; no doubt, other colleges alluded to in the above quotations, might defend themselves with equal success.

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In a report, in which so many interests of the college are brought into view, and in which it is deemed proper that some of its internal regulations should be stated and defended, it may be justly expected by the committee, that some notice should be taken of certain statements lately made respecting all our colleges by a writer, who from his situation might be believed fully acquainted with the real state of facts, and to have weighed with some care the import of his declarations. Ordinary mistakes or misrepresentations should pass unheeded; but, in the present instance, silence might be interpreted as an admission, that charges of very grave import have been correctly preferred. This is the apology, if any is necessary, for making two of these charges the subject of remark.

According to this writer, " the public examinations at most of our places of education, except West Point, have been miserable farces, which have imposed on nobody; not even on the students subjected to them." " It is idle," he says, to think of hurrying, in a single day, through the examination of sixty young men in the studies of a year," &c. Though the gentlemen of the committee may be aware how little applicable this censure is to the examinations of this college, yet it may not be improper to state with some particularity, how these examinations are in fact conducted. If they are really farces, it is time that a reform should commence. Each of our classes is examined twice a year. At the close of the year, the three lower classes are examined in the studies of the year, each of them in two divisions. Somewhat more than a day is assigned to each class; and as each class is examined in two divisions, the time is the same as if each class was examined in a body about two days and a half. At the close of the month of April of each year, the three lower classes are examined in all their studies from the time of their admission to college. The time is extended; in other respects, the examinations are the same as before. In April, the senior class is examined in the studies of the senior year to that time; and the mode of the examination is the same as of the other classes. In July the Seniors are examined for their degrees. They are examined in two divisions, and on the whole college course. For a number of years past, this examination has extended through not less than three days, and sometimes three days and a half, at the rate generally of eight hours a day. As the class is in two divisions, this is the same as an examination of six or seven days for the whole class together. All examinations in the languages are *ad aperturam libri;* and in no study, does any understanding exist between the examiner and the examined as to the course which the examination is to take. It is very seldom, that any student is absent from the examination of his class; and never, especially from the examination for degrees, except for very urgent reasons. Whenever individuals are absent, they are always examined afterwards, and more particularly, than they could have been, at the regular time. For absence, therefore, there is no inducement. It should be added, that during the examination for degrees, the ordinary instruction in the college is uninterrupted; and during the other examinations, the interruption is only partial. If all this is a miserable farce, it would be interesting to know what would be a reality. If it is in fact a farce, it has not been suspected either by those who examine, or by those who are examined; or they have not rightly apprehended the meaning of the term. That these examinations can admit of no improvement, is not pretended. Any suggestions from the committee or the corporation on this subject will be received with all possible attention. It ought, however, to be distinctly stated, that, in the opinion of the faculty, the examinations of the classes, as now conducted, are a powerful incentive to study, and afford the means, especially in connection with other opportunities, of forming a satisfactory opinion of the attainments of each individual student.

The other charge, which, on the present occasion, appears to demand notice, is, that in none of our colleges is there any thorough *teaching*. "The most that an instructor now undertakes," says this writer, "in our colleges, is, to ascertain from day to day, whether the young men who are assembled in his presence, have probably studied the lesson prescribed to them. There his duty stops." And again—"Not one of our colleges is a place for thorough *teaching*; and not one of the better class of them does half of what it might do, by bringing the minds of its instructors to act directly and vigorously on the minds of its pupils, and thus to encourage, enable and compel them to learn what they ought to learn, and what they easily might learn." That the faculty of this college have always fallen upon the best methods of instructing, or, in all cases, have done the utmost which it has been in their power to do, they will not say; but to the assertion, that all they undertake "is to ascertain from day to day, whether the young men assembled in their presence have probably studied the lesson prescribed to them," they would oppose an unqualified denial. The most abundant pains are taken to explain and enforce the principles of every branch of learning to which the students are required to attend, not only when they are assembled in classes, but often, as they need assistance, individually. If the faculty know what is meant by "bringing the minds of the instructors to act directly and vigorously on the minds of their pupils," they think they should fail in their duty to themselves and to the institution, if they did not assure the committee, that, in their belief, something very much like it exists here.

This writer goes on to ask, "Who in this country, by means here offered him, has been enabled to make himself a good Greek scholar? Who has been taught thoroughly to read, write, and speak Latin? Nay, who has been taught any thing at our colleges with the thoroughness that will enable him to go safely and directly onward to distinction in the department he has thus entered, without returning to lay anew the foundations for his success?" That the students of this college learn every thing in the several branches here taught, which it is desirable to know, is not maintained. Their instructors are very far from laying claim to such attainments themselves; nor have they known or heard of any set of instructors, either at home or abroad, whose just pretensions rise so high. That in classical literature, particularly, all is not accomplished which in other circumstances might be hoped for, is not denied. That this branch of the collegiate course is gradually improving, amidst all the discouragements under which it labors—discouragements which originate chiefly from without; that many scholars leave the college each year so well versed in the Greek and Roman classics as to perceive and relish their beauties, and to be able and disposed to make future advances in the same department; and that all who graduate derive from their classical knowledge important aid in their professional studies, and in their other pursuits, is what we believe. That in every department, our students are taught with that thoroughness which enables them, with proper exertions—a condition so far as we know, presupposed in every country—" to go safely and directly onward to distinction in the department they have thus entered, without returning to lay anew the foundations for their success"—there is no higher evidence to be produced, than general notoriety; and to this the appeal is made.

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[*As the two parts of this report were written independently of each other, a few of the same topics were considered in both. These topics have been retained in the second part, so far only as they were introduced in a somewhat different connection.*]

REPORT OF THE COMMITTEE OF THE CORPORATION.

To the Corporation of Yale College:—

The committee appointed "to enquire into the expediency of so altering the regular course of instruction in this college, as to leave out of said course the study of the dead languages substituting therefor other studies, and either requiring a competent knowledge of those languages as a condition of admittance into the college, or providing instruction in the same for such as shall choose to study them after admittance," respectfully report;—

That aware of the magnitude of the proposition presented to them, and its direct bearing upon the interests and reputation of the college, looking as it does to a fundamental change in its organization and laws, and involving a radical departure from the original object of its establishment, the committee deemed it advisable to refer the subject to the faculty of the college with a request that their views, in regard to the matter, resulting from long experience and careful observation in the business of instruction, might be fully explained, and their objections to the proposed innovation adduced and discussed.

The committee are much gratified that the faculty, in the document herewith submitted, have taken a comprehensive view of the whole course of instruction, and developed the elements of a liberal education and the principles by which it should be regulated and administered; exhibiting forcibly the intimate connexion which classical literature has with other learning and the sciences, and the facilities afforded by its preliminary study in their attainment.

The ability with which this subject has been discussed, by the faculty, relieves the committee from a high degree of responsibility.

This paper having fully and ably exhibited the considerations which ought to be weighed and regarded in forming a decision upon the contemplated measure, it may be considered that, by its presentation, the committee have fulfilled the trust confided to them. It is hoped, nevertheless, the importance of the measure will be considered a sufficient apology for briefly detailing the grounds of their opposition to a scheme calculated in their judgment fatally to affect the prosperity of the college.

In the universities of Europe, as well continental as insular, a thorough knowledge of the ancient languages seems to be universally deemed an important prerequisite to the attainment of very considerable success and reputation in either of the learned professions; while ignorance of those languages, constitutes an obstacle to literary distinction, seldom surmounted.

The learned world long ago settled this matter, and subsequent events and experience have confirmed their decision. By the estimation in which classical literature is held in any community, its advancement in civilization and general learning may be satisfactorily ascertained. On this subject in Europe, a concurrent opinion and practice appear to prevail among men of distinguished learning, or of professional, or political eminence; and in our own country, it is presumed, there is not great diversity of sentiment, in the same class.

It must, indeed, be admitted, that in France, immediately preceding and during the revolution, the learned languages were neglected.

But that example, neither by its literary or moral results, can demand our imitation. What have been the effects of that neglect upon the literature of that country? Notwithstanding highly important improvements and discoveries have there been made in some of the sciences and arts, and the mineral and geological kingdoms have been penetrated and explored with untiring zeal, and matchless ability, and the arts of war brought to great perfection, her literary fame is eclipsed. In literature, Germany has left her far behind, and the effect upon the learned professions, and the statesmen of France, is already perceived.

If, with the enlightened opinions and settled practice of one portion of Europe, and the disastrous experience of the other before us, we consign classical literature to a secondary place or inferior rank in the course of instruction, and even admit and graduate students, as it is proposed to do, without the slightest knowledge of the ancient languages, may we not expect that the high literary reputation which this institution has hitherto maintained will be essentially impaired? Indeed this college would probably, at no distant day, sink into a mere academy, while its degrees, being no longer evidence of great literary and scientific attainments, would become valueless. The standard of scholarship would not only be lowered here, but we should become directly accessary to the depression of the present literary character of our country.

On the contrary, we are the people, the genius of whose government and institutions more especially and imperiously than any other, demands that the field of classical learning be industriously and thoroughly explored and cultivated, and its richest productions gathered. The models of ancient literature, which are put into the hands of the young student, can hardly fail to imbue his mind with the principles of liberty; to inspire the liveliest patriotism, and to excite to noble and generous action, and are therefore peculiarly adapted to the American youth. To appreciate justly the character of the ancients, the thorough study and accurate knowledge of their classics, in the language of the originals, are indispensable; as the simplicity, energy, and striking peculiarities of these pristine exemplars of freedom which are forcibly and beautifully displayed in their models of classic literature, are scarcely more discoverable in ordinary, or even the most faithful translations, than are the warmth, animation, and intellectual illumination of the living, active and intelligent being, in the sculptured imitation of the statuary.

While classic literature is pursued in other civilized, and Christian countries, with constantly increasing avidity, every measure having a tendency to depreciate the value and importance, or to discourage the pursuit of high classic attainments, in our own country, should be resisted, and no reasonable effort should be omitted to enhance the estimation in which education shall be held by the great body of the community.

Let the value of a collegiate education be reduced and the diffusion of intelligence among the people would be checked; the general standard of intellectual and moral worth lowered; and our civil and religious liberty jeoparded, by ultimately disqualifying our citizens for the exercise of the right and privilege of self-government.

Interwoven therefore, as the measure under consideration is, with the structure of our invaluable institutions; endangering their durability; and tending as it does to discourage, by undervaluing what has hitherto been deemed an important branch of learning, and involving a departure from the well and long established opinions and practice of the learned and wise, the committee would for these reasons alone, pronounce its adoption a most hazardous experiment.

The committee, however, do not rest their opposition to the proposed plan solely on the considerations already suggested. The thorough study of the ancient languages, particularly the Latin and Greek, not only before but subsequently to an admission into college, they are fully satisfied, is, in many respects decidedly and positively useful to the pupil. In the intellectual discipline of youth, the importance of the study of those languages, in their opinion, cannot be reasonably denied, and will hardly be questioned by many whose judgments are guided by the light of experience. Such study carries the young pupil back to the earliest era in the history of mental efforts, lays open to him the most simple and original operations of the mind and acquaints him with its brilliant and unrivalled productions. It stimulates to industry and severe and faithful application, by proving to the student that the mines of learning can be penetrated only by unceasing exertion, while it admonishes him of the inutility and fate of genius when unaided by deep and laborious research. The student's memory is thus rendered retentive; his recollection quick, and his power of critical discrimination more accurate. Beginning with language in its primitive simplicity and tracing its progress to its present state, the student can hardly fail to improve his taste and to enlarge his capacity to think, and to communicate thought.

The acquaintance with the elements of language and the mythology, as well as the chronology and geography of the ancients, which he derives from their classics, naturally excites in the mind of the student, an ardent desire of knowledge, while his imagination is fired by their poetry and eloquence. The heroic exploits they celebrate may indeed arouse his ambition, but the wisdom of their precepts will enlighten and guide his judgment, and temper his ardor, directing him to the fields of science, with the hope of obtaining valued, but bloodless trophies, in the conflicts of mind. Having access to the depositories of the earliest and most splendid results of mental labors, he seizes the refined treasures of antiquity, and pursuing the operations of gifted intellects, in later times, his mind becomes well stored with knowledge, and he is fitted not only for intercourse with the learned throughout the world, but for general usefulness.

It is urged that the dead languages are not necessary nor used in the intercourse and business of life even by the scholar, and that the time spent in acquiring them is, as to all practical results, lost. But the committee do not consider this objection well founded. Who would consent to part with the mental discipline the study of algebra imposes, or direct the student to lay aside Euclid because the perfect arrangement of the signs of the one, or the problems and demonstrations of the other, may not be directly and practically useful to men of business? These exercises give vigor to the mind, generate a habit of close and connected thought, and prepare the student for the successful use of the materials he may have derived from miscellaneous learning. But the reasons for dispensing with the study of classical literature are not more cogent, resting as they do, on the inadmissible postulate, that the student should be confined to merely practical learning.

The study of Greek as a branch of elementary education, not only discloses the degree of perfection to which language was early carried and its susceptibility of almost mathematical precision, as a mean of communication, but, at the same time, brings the student to the contemplation, and to an intimate knowledge of a most extraordinary and unexampled people, whose intellectual history exhibits unrivalled success, and must continue through the progress of time to be an object of intense and augmenting interest. If for no other reason, as the means of cultivating a knowledge of the philosophy and powers of language, and improving taste, and style, the ancient languages should be early, faithfully and perseveringly studied.

The utility of classical literature to the learned professions however, presents a further and in the opinion of the committee, a strong motive for its holding a prominent place in the course of collegiate studies. High respectability without its aid, may indeed be attained, as it has been, by lawyers of extraordinary mental endowments, but such, it is presumed, will generally be found to lament their inability to command the rich illustrations and embellishments, which the scholar copiously draws from classic learning. The deep and intimate knowledge of the human character too, so essential to the lawyer and the statesman, can be most effectually attained by exploring and developing the springs of human action, in all ages. By the various comparisons thus instituted, the indispensable qualification of a lawyer, a statesman, or a judge, sound and discriminating judgment, may be greatly improved, if not actually acquired. This inestimable characteristic of wisdom, is not formed by casual and superficial views of men and things. They ought to be studied, investigated and scanned industriously, deeply, carefully and minutely through all the developments of history up to the ancient classics, in their original language, by him who desires distinction as a jurist or a statesman.

To high attainments and extended usefulness in physic and surgery, the importance of a knowledge of the Latin and Greek languages will hardly be denied, when it is recollected that a great portion of the language of those arts, even in their present advanced state, has a classic origin.

Without classical literature, the Divine will experience serious embarrassment in a profession of tremendous responsibility and infinite moment. The ancient languages having been made the organ of communicating revealed religion to man, the originals must be considered the standard of accuracy and truth, and the only safe resort to explain and remove difficulties and doubts too often occasioned by translations either ignorantly or wilfully erroneous.

In a matter of such deep concern, what teacher will be disposed to forego any available means of ascertaining the truth? As by biblical criticism, controversies involving eternal interests are often determined, faithfulness to the souls of men imposes an imperative obligation to read and know the Scriptures in their original simplicity and purity.

Indeed to dilate on this point cannot be necessary, as ignorance of classical learning and the safest means of explaining the oracles of truth, in this profession, must be generally deplored. If then we desire, in accordance with the example and intentions of the Fathers and Patrons of this Institution, to know and communicate the truth in its simplicity, beauty and force, the ancient languages will here become the objects of more intense pursuit, and augmented patronage. The single consideration that divine truth was communicated to man in the ancient languages, ought to put this question at rest, and give to them perpetuity. Besides, classical literature, while it opens the most copious sources of illustration and explanation, enables him who has made proficiency in it, with the more effect, to press the performance of duty.

It has been urged that if the study of the ancient languages shall no longer be required as a preliminary of admission into the college, or as a part of its regular course of studies, the time of the student may be usefully employed in acquiring a knowledge of his own and other modern languages. But so intimately is the English connected with, so directly is it derived from, compounded of and built upon the ancient languages, that, to the thorough knowledge of it, the study of those languages is indispensable. Indeed, these languages may be considered the basis of most of the modern.

That the modern languages most extensively spoken should be learned, both by students who expect to be called abroad, either by business or in pursuit of science, and by those who seek literary distinction, the committee willingly concede. But the readiest way to acquire the modern languages in general use, is to become well versed in the ancient, from which they are derived.

By a competent understanding of Latin, it is generally admitted, the progress of the student in French, is much facilitated. The committee therefore, are satisfied, that in the more advanced periods of collegiate life, when the student shall have made sufficient progress in the ancient classics, the French may be studied without any derangement of the established system, and with great advantage as a parallel course. Even the French, however, in their judgment should not be substituted for the classics, either as a condition of admission, or in the regular course of study, or as a test of scholarship. The committee do not deem it an equivalent course. The Spanish and Italian are so easily acquired by one who is versed in Latin, that they may well be considered as appendages to it, and need not in the opinion of the committee, be included in a systematic course of collegiate studies, where this language is taught ; much less are they entitled to precedence. The present regulation which allows the students to study French and Spanish at their option, the committee deem judicious and proper, and they are of opinion that suitable facilities should be continued to all who may signify their desire to study those languages, when properly advanced in the ancient.

The considerations briefly adverted to, in the necessarily rapid view which they have taken of the subject referred to them, have brought the committee to the conclusion that it is inexpedient so to alter the regular course of instruction, at this college, as to leave out of the same, the study of the ancient languages.

Fully convinced of the importance of the thorough study, and an accurate knowledge of the ancient languages, and believing that much misconception regarding their utility has arisen from the fact that they have been but partially studied and acquired, the committee have seen with approbation, that within the last twenty-five years those languages have here received increased attention, and that the classical and other attainments required as a qualification for admittance into the college, have been considerably augmented. The effect of such augmentation has evidently been to elevate the character of the institution, and the standard of scholarship. The period of academic preparation having been prolonged, and consequently the age, at which students will ordinarily apply for admittance extended, they are enabled the more successfully to pursue the studies requiring maturity of intellect, and further to advance in learning and science.

Approving highly the course which has hitherto been pursued, the committee entertain the opinion that the terms of admission may very properly, be gradually raised so as ultimately to render necessary, as a condition of admission, much greater acquirements, especially in the classics, than the laws of the college at present prescribe. The committee, however, do not deem it advisable that the corporation should act on this subject, until they shall have availed themselves of the information and experience of the Faculty, and received from them a specific recommendation.

Yale College, September 9th, 1828.

Art. IX.—*The History of Sea-Serpentism, extracted from* Samuel L. Mitchill's *summary of the progress of Natural Science within our United States, for a few years past; read before the New-York Lyceum, at a succession of sittings during October*, 1828.—*No.* 35. *The* Sea-Serpent.*

(Communicated for this Journal.)

This subject, the author observed, would scarcely be worthy of notice, before this learned and respectable assembly, if it had not happened, that during several years, it, or something so imagined or so called, had frequently been presented for public consideration; and that paragraphs and statements in the newspapers and journals, do yet, from time to time, attract the attention of their readers.

This alleged monster of the deep first haunted the coast of Massachusetts, and frightened more particularly the neighborhood of Gloucester with his presence. Observations were made, and evidence was collected to a large amount. These were so considerable and imposing, that the Linnean Society of New England published a book on the subject, with the figure of the enormous reptile under the name of *Scoliophis*. As the fishermen and naturalists could not catch him and bring him ashore for inspection, it was concluded to fortify the story by oaths. Accordingly, affidavits were made

* *Note.*—We give place to the *scepticism* of the learned author, although not ourselves *sceptical* on this subject. We do not see how such evidence as that presented by Dr. Bigelow—Vol. II., p. 147 of this Journal—particularly in the statements of Captain Little of the Boston frigate, and of Marshal Prince and family, and of Mr. Cabot, can be set aside—although we have no doubt that there have been on this subject both error and imposition; and we are far from believing that every thing that has been called a sea-serpent has really been such.—*Ed.*

to great extent, containing the particulars of what the several deponents believed they had seen. And, as far as swearing went, such solemn declarations presented a strong case. Their operation however upon my mind was, that there was nothing better to show than those statements upon paper; which were, in no sense of the words, proofs of the facts, but merely expressions of the opinions formed by the deposing witnesses of what they had observed in the water. I, who was a believer in the first instance, was gradually sworn into scepticism; which finally ended in incredulity.

About this stage of the panic, General David Humphreys did me the honor of a visit, and requested me to listen while he read a manuscript. To this I instantly consented. I discovered that my distinguished friend had visited Massachusetts for the express purpose of collecting all the testimony he could find concerning the Sea-Serpent. He was highly delighted with his success; and had reduced his researches into the form of letters addressed to Sir Joseph Banks, then President of the London Royal Society. He evidently intended to take the lead of the Linnean Society, and to acquire the honor and glory of making the wonderful intelligence known first to the sçavans of Europe. He did not vouchsafe, even to name me in the communication. After a very pleasant interview, during which I found that he positively considered himself right in the investigation, and I determined on my part to enter into no discussion about it, he requested me to receive the writing, and engage some bookseller to cause it to be put to press without delay. The reason for this was, that he was obliged to return forthwith to New-Haven. I made a contract in his behalf, and directed the proof-sheets to be sent to him there. I had a lucky escape from an association with the extraordinary creature.

Afterwards, a mutilated specimen of a snake, killed on the land, somewhere thereabout, was brought to me preserved in alcoholic spirit. This had been exhibited as the spawn or young of the Great Scoliophis. The head, which contains the strong *ophiological* characters, had been crushed and destroyed. But, as far as I could judge, from the formation of the belly and tail, it had been a native of the land, (apparently a *coluber*,) and had, of course, no pretension to claim kindred with its pretended parent of the ocean.

I was the better enabled, I thought, to form a more correct opinion, relative to the matter, by reason of my possessing, in my museum, at the time, four true sea-serpents, which my navigating friends had brought me from the Gulf of Mexico, and the Chinese Sea.

The history of sea-serpentism, is a very memorable part of the sayings and doings in this enlightened age and country. For the benefit of the present generation, and of posterity, it ought to be written. In proceeding to pen a short sketch of it, I must premise, that I am one of the last persons in existence who would presume to put a limit to creative power. I admit that the all-mighty being could make a water-snake as easily as a fish; and that such an animal might be as big as a *Kraken*, as easily as of the diminutive size of the *Stickleback*. Yet, on reviewing these legends of the times, there is found such a propensity towards the strange and the marvellous, that the men of the present day show a credulity very much resembling that of the remote ages, when the terraqueous globe was peopled with gorgons, mermaids, chimeras, hydras, dragons, and all the monsters of fabulous zoology.

(a) The first tale I remember to have considered seriously relative to it was this: it had been determined, they said, to put a steam boat in operation at Boston to coast along shore and to convey passengers. It was foreseen that such a vessel would traverse the currents and pass among the islands with an ease and a speed unknown to boats moved by oars and sails; and of course, much of the business of transporting passengers would be taken away from the small craft heretofore employed. The large boat would thus destroy the small ones, or, as was expressed by another word, devour them. Under these forebodings, the steam-vessel made a trip, with favorable auspices. Some wag, the account proceeds, wrote for one of the gazettes, an allegorical description of a sea-serpent, that had been descried off Nahant and Gloucester, and had probably come there to consume all the small fish in the place. The narrative, given with such grave diction and imposing seriousness, was received by many as an actual and literal occurrence, and credited accordingly.

(b) Long Island Sound put in a claim for a sea-serpent. On this fiction I am well satisfied of the particulars that follow. An active young fellow who had become weary of ploughing the land, bought a little sloop of about fifteen tons, which I remember to have seen; and resolved to try his luck in ploughing the waves. He named his vessel the

Sea-Serpent. She was mostly employed in carrying country produce to the New-York market, and in bringing manure back, with the advantage of passengers when any offered. This boat was on her way from Mamaroneck harbor or thereabout toward the city, and was met by a sloop from that place, a short distance from City Island. The captain of the latter, on arriving at home, was eagerly interrogated by a quidnunc for news; and being a man of some humor and fancy, told his neighbor, the querist, he had just seen the sea-serpent. He then described, how (alluding to the barrels on deck) he had seen the bunches on his back; how high the head (meaning the bowsprit) was out of water; how the black and white colors (meaning the painted waist) were variegated; how he saw the lashing of the tail, (meaning the motion of the boom in jibing as she was going along before a fair easterly wind;) that this sea-serpent was proceeding with a speed equalling at least from five to six knots an hour, which made all white before him, (meaning the foam at the bows.) The good man took the joke in real earnest, went away and told it to a sensible acquaintance. This latter wrote a formal and solemn account of it; which, travelling an extensive round in the sheets of intelligence, was finally embodied in the aforesaid book, where it is registered as a part of the evidence.

(c) It was about this period of these transactions that I received from Boston an ichthyological production, enclosed in a letter, respectfully written, and with postage paid, submitting to me whether that article was not a piece of the sea-serpent's hide? It had been found on the shore of the region which the alarming visitor frequented; and was supposed to have been separated from his body by one of the musket balls which had been fired at him, and washed ashore. To this serious communication, I returned for answer that it was simply a portion of skin with closely adhering scales, belonging to the bony-scaled pike, (Esox asseus,) an inhabitant of the Atlantic ocean.

(d) So much curiosity and excitement were now raised, about the sea-serpent, that he was a prominent topic of conversation. The feeling was more intense, inasmuch as it was confidently declared he had been frequently observed near boats and vessels. It was at length concluded to fit out an expedition, expressly for the purpose of catching him, with a select crew, under the command of Captain Rich.

Day after day he cruised over tracts where the sea-serpent had, according to information, been observed, without discovering any thing like him. At length, a creature was descried, which some of the men on board said they had seen before, and that it was the sea-serpent. The captain pursued the game a considerable time longer, with much vigilance and patience, until it was at a distance near enough to be harpooned. He was taken on board, and found to be a fish of the Mackerel family. I saw the preparation of it in the Greenwood Museum, and satisfied myself that it was an individual of a well known species called *Tunny* in the Mediterranean, and *Albicore* in the Atlantic sea.

After the capture of the fish, the persons who, when they saw him in the water, declared positively that he was the sea-serpent, now changed their minds, and swore he was not.

At length the man of successful exertion arrived with his prize; and unexpectedly and unfortunately drew upon him the displeasure of his employers for attempting to impose upon them a *Horse-Mackerel* (as they call it) for a *Sea-Serpent!* He told me the story himself.

(e) In this fervor of opinion, it was supposed for a time that a sea-serpent existed in Lake Ontario. A coasting navigator, somewhere between Kingston and York, had several times during his trips observed among the islands and rock something that appeared to be a long animal with vertical flexures of the back, resembling lumps or humps of variegated black and white hues. He told some of his acquaintances what peculiar appearances had presented themselves to his view; and that he intended the next opportunity to take a more close and correct survey. He did so, shortly after, when the whole phenomenon ascended into the air! It turned out to be a speckled mother-duck, with a numerous brood of young ones. They swam in a line, with the parent bird at the head. And as they rose and descended on the undulations, gave an appearance so like that ascribed to the sea-serpent, that the captain, though a wary man, would have solemnly declared, until he was undeceived, his belief in the existence of a sea-serpent there!

(f) Lake Erie brought forward pretensions too for a sea-serpent. One of the coasting vessels, navigated by three men, as she was steering eastward from Detroit, discovered something afloat on the hither side of the islands called "The Sisters," which, when she arrived at the place of her destination on the southern shore, was reported by the men at the tavern and the printing office, to be the very creature. Mr. Printer wrote a paragraph on the subject, and inserted it in his paper, in which it travelled far and wide. It may be relied on that this alleged inhabitant of that inland sea, has been reduced to genus and species, by a distinguished naturalist, and registered very orderly in zoology. Now let us find what the production really turned out to be. The sheriff of the county, a sensible man, heard of the marvel, and conceiving that he knew as much about the lake as any person whatever, went on board, full of curiosity, to make inquiry about it. He found but one of the people on board, whom he interrogated closely concerning the wonderful sight, with which he and his associates had entertained the neighborhood. The sailor was soon implicated in contradictions. The querist, aware of the fellow's confusion, asked him if he was not ashamed to propagate such falsehoods? He then said, if the sheriff would not be affronted, he would relate the whole story just as it was. At the place aforesaid, they passed a dry tree afloat; and concluding that the butt or root would do for a head; some knots on the trunk for knobs or bunches; and the top for a tail; they would have a little pastime by telling a story of a sea-serpent, which they thought their lake was as much entitled to as any other water. The whole three had agreed to tell the same tale and support it!

(g) When the skin, &c. of the huge basking shark, that had straggled from the Northern Ocean and had been killed in Raritan Bay, (Squalus Maximus,) was exhibited in New-York city, the inhabitants were openly and earnestly invited by notice in words at length displayed in front of the house, to enter and behold the sea-serpent. The conceit took very well!

Now, after all these mistakes, deceptions, and wilful perversions on the subject, every person of consideration may admit that the gambols of porpoises, the slow motions of basking sharks, and the yet different appearances of balœnopterous whales, all of which have fins on their backs, may have given rise to those parts of the narrations, not already herein commented upon.

INTELLIGENCE AND MISCELLANIES.

1. *Proceedings of the Lyceum of Natural History, N. York.*

[Continued from page 191, of this Vol.]

May, 1828.—Mr. N. H. Carter presented several boxes of minerals, plants and animals collected by himself during his recent visit to the island of Cuba. Among them were observed specimens of the *Capromys furnieri*, *Strix flammea*, *M. avicularia*, seeds of the *Mammea americana* and of the *Adansonia digitata*, and an extensive series of the bituminous siliceous and calcareous minerals of that island.

A member exhibited to the Society a specimen of the *Leonice gigantea*, the largest of the marine Annelides being nearly four feet in length. It was cast on shore alive in one of the Antilles. When first captured it gave a smart electric shock to the person who seized it, which was followed by a general eruption over his body.

Dr. DeKay gave an analysis of the memoir of Quoy and Gamard on the coral islands of the Pacific. This was done in accordance with a standing rule of the Lyceum which requires an abstract or analysis of all works presented by their authors. Messrs. Quoy and Gaimard suppose, (contrary to the received opinion,) that those animals which work in solid masses and form coral reef and islands, do not in fact operate at a lower depth than from 25 to 30 feet. From various facts and analogical reasonings they demonstrate that these animals commence their operations only on the peaks of submarine mountains working gradually to the surface, and they deny that these animals ever can form precipitous submarine mountains, rising from the depths of the ocean.

Dr. Torrey, after alluding to various notices in scientific journals respecting the presence of mercury in sea water, proceeded to mention an experiment which he had caused to be made in order to test the accuracy of the observation. Through the attention of Capt. Bennet of the packet ship

New York, a small plate of polished gold of known purity was attached to the bottom of a vessel where any great friction from the motion of the vessel was avoided. The ship sailed to Liverpool and returned to this port. The gold plate exhibited in no wise the presence of mercury and had retained its original brightness.

A crystal of Beryl of unusual size was received from Ackworth, N. H. It had no perfect termination, was nine inches in its transverse diameter and weighed 47 pounds.

Mr. Chilton gave the results of his examination of a bottle of water from a mineral spring in the island of Cuba. When the bottle was opened, a strong odor of sulphuretted hydrogen gas was emitted. It is a weak mineral water containing not more than 3 or 4 grains of solid matter in a pint. Its chief ingredients are sulphate of lime and muriate of magnesia.

Dr. DeKay communicated his observations on a paper in the Transactions of the Royal Society of London for 1827, entitled " a newly discovered genus of serpentiform fishes, by J. Harwood, Prof. of Nat. History, &c. Dr. D. in his paper shewed the strong probability that the new genus Ophiognathus of Prof. Harwood had been anticipated as far back as 1819 by Dr. Mitchill who had described a similar animal under the name of Saccopharynx. An account of this genus was subsequently published in the first volume of the Annals of the Lyceum.

Mr. Roberts of Portsmouth, N. H. presented the horns of several remarkable animals from Zanguebar on the north east coast of Africa. Among them were the horns of the *Bos caffer*, *Antilope oreas* and *A. leucophea.*

June.—Mr. Barnes announced that he had recently received information that the *Senecio oboratus*, a plant growing in the northern part of the state of New York, had proved in many instances a deadly poison to sheep.

Dr. Mitchill communicated information of the fact that there had been a recent fall of meteoric stones at Nashville, Tennessee. Further details were expected.

Mr. Featherstonehaugh offered some observations on the remarkable fossil deposits of Stonesfield and Tilgate Forest, accompanied with a series of fossil remains from these and other localities.

Mr. Schoolcraft presented a collection of animals from the neighborhood of Lake Superior with remarks upon their geographical distribution, and the popular names of each in the Chippeway tongue.

Dr. DeKay read a description of a large species of Squalus recently captured on the American coast. The author observed that the first descriptions of the S. maximus were so imperfect that modern naturalists have considered it a doubtful species and have accordingly described several large individuals of this genus as new species. Dr. DeKay considers the *S. pelerin*, *S. gunnerianus*, *S. homianus*, *S. elephas* and *S. rhinoceros* as all belonging to the *S. maximus*, to which also he refers the individual under consideration. The *S. peregrinus*, pinna anali nulla, is certainly a distinct species. The most striking peculiarity observed in this specimen was the presence of true baleen. Each branchial opening was furnished with a fringe of baleen four inches in length. This was composed of a great number of distinct flattened fibres a tenth of an inch wide at their origin and tapering gradually to minute threads at their extremities. In color, texture and flexibility this resembles very much the baleen of the *B. mysticete.* The laminae are extremely regular in their position ; thirty of them are included within the space of an inch, and they extend the whole length of the branchial apertures. The author concluded by remarking that all inferences respecting the size of a shark founded on the magnitude of the fossil teeth alone must be erroneous, as the individual just mentioned was twenty eight feet long and its teeth were only 1-2 an inch in length. There are fossil sharks' teeth in the Cabinet of the Lyceum 4 inches long which by parity of reasoning belonged to an animal 220 feet in length.

Mr. Barnes stated some facts which he had observed respecting the Serpentine bowlders scattered about on the surface at East Chester, N. Y. These bowlders were of various sizes from 8 to 30 feet in diameter, and among them Mr. B. observed a large mass of stellated asbestus, (steatite.)

Mr. G. C. Morgan presented a skeleton of the *Capromys prehensilis* and a series of the land shells of Cuba.

Dr. Van Rensselaer made a communication relative to the action of salt water upon copper. A merchant of this city, a large ship owner, had stated as the result of his experience his entire disbelief in the utility of the galvanic method proposed by Sir H. Davy, to preserve copper. He considers that a more efficacious protection of the copper would be to cover it with a coat of green paint. The plan was suggest-gested and adopted of applying paints of various colors and composition to different parts of the bottom of a vessel about to sail to the East Indies, in order to ascertain their relative preservative properties.

Mr. Barnes announced that bituminous coal of a superior quality is found at Williamsport, on the western branch of the Susquehannah, and can be delivered at a reasonable rate at Philadelphia.

The President announced that there were two vacancies in the class of Honorary Members occasioned by the decease of Dewitt Clinton and Sir James Edward Smith.

2. *On the blue appearance of the heavens; by Benjamin Hallowell, Alexandria, D. C.*—The cause of the blue appearance of the heavens, I have never seen satisfactorily explained. I conceive it to be occasioned by our looking at the *dark vacuity* beyond our atmosphere through an illuminated medium. Were there no atmosphere, it is universally admitted the appearance would be perfectly black, excepting in the particular direction of the sun or some other of the heavenly bodies; and since the atmosphere is transparent, this blackness (if I may use the expression) must be seen through it, only somewhat modified by the rays of light reflected by the atmosphere to the eye, from the direction in which we are looking. For this reason, the clearer or more transparent the atmosphere is, the darker is the appearance of the heavens—there is then less light reflected by the atmosphere to the eye. In the zenith the appearance is always darker than nearer the horizon; and from the tops of high mountains, the heavens in the zenith appear nearly black.

3. *On the twinkling of the stars, and the deception in the number visible to the naked eye on a clear evening; by Benjamin Hallowell.*—It is a familiar fact, that if a person take a stick with one end ignited, and cause the ignited end to

revolve swiftly, there will appear to be a continued circle of light. If the circle be increased in size, or if the ignited end be made to revolve more slowly, the circle may be made to appear much brighter on one side than on the other, or it may appear bright on one side and entirely broken on the other. The twinkling of the stars and the deception in the number of stars visible to the naked eye on a clear evening, is somewhat similar to this. A fixed star having no visible diameter, only one stream of the rays of light that proceed from it can enter the eye; and since the fixed stars are at such an immense distance, the particles of light from one of them that would fall upon so small a surface as the pupil of the eye, must be at a considerable distance from each other. When therefore a particle of light from a fixed star falls upon the eye, it produces a vivid impression: this impression becomes gradually dimmer, until another particle arrives, producing a vivid impression again. This causes the *twinkling*. Here the circle is unbroken—another particle arrives, before the impression made by the former one has entirely vanished. But the particles of light which proceed from more distant stars, fall upon the eye at too great intervals to keep up a continued image. Hence when a particle of light from one of these stars falls upon the eye, it produces a perception of a star; but when we endeavour to contemplate this star, it is *invisible*, because the image formed has vanished, and another particle has not yet arrived to renew it. In this way we are led to suppose there are more stars visible, than upon examination we find.

The only cause why telescopes enable us to see stars that are invisible to the naked eye, is, that they concentrate the rays from so large a surface, as to keep up a *continued image* of the star.

4. *On the cause of hail during warm weather; by Benjamin Hallowell.*—Large hail frequently falls during very warm weather, which we have had repeated instances of, the past summer. This phenomenon occurs only when there is an excessive accumulation of electricity in the atmosphere, and it may be accounted for in the following manner. Two highly charged clouds in opposite electric states, coming within the electric influence of each other, displace the air from between them so as to form a passage for the electric fluid, while the moisture remains. This sud-

den displacement of the air produces such a degree of cold, as not only to *freeze* the vapour, forming the nucleus of the hail, but to reduce the temperature of that frozen vapour far below the freezing point. When therefore the warm air comes in contact with this frozen vapour, the moisture is precipitated upon it and freezes. In this way the hail is increased as it falls to a very great size.

Sometimes the temperature of the hail is so raised before it reaches the ground, by the constant precipitation of moisture upon it, that it is melted, and falls in extremely large drops of water.

5. *Anthracite coal, and liquids, in quartz crystals.*—The students of Rensselaer school have, during the present summer, found numerous quartz crystals in the calciferous sandrock one mile north-easterly from this school, which were terminated by six-sided prisms at each end, containing anthracite coal. They found two specimens which contained a liquid, and one which has a piece of coal floating in the liquid.—*Prof. Eaton.*

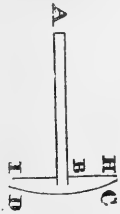
6. *Remarks upon the effect of a blast of air between contiguous surfaces, in a letter to the editor dated West Point, Sept.* 4th, 1828.

To the Editor.

Sir—I beg leave to submit to your consideration an explanation of the philosophical question relating to the two Cards, since seeing the explanation in your last, I have tried the experiment but cannot convince myself that the explanation, there given, is satisfactory. It has been shown in Nat. Phil. that "the force which a current of wind exerts upon an inclined plane, varies as the sine of the inclination, which the direction of the wind makes with the plane;" therefore, if the inclination is nothing, or if the wind passes parallel to the plane, the pressure will be nothing. But since the wind passes directly over the plane, it must remove the atmosphere from the space through which it passes, and by its velocity, it will oppose a resistance to the pressure of the atmosphere, which is exerted above it, and the pressure on the surface over which the wind is blown, will be less than the pressure of the atmosphere, and consequently less than the pressure on the other surface of the

Card, it will then be pressed forward by the atmosphere.

Since the explanation depends entirely upon this principle it may be proper to prove it experimentally. This may be done by tying a strip of paper to one extremity of the barrel of a quill, (A B) as represented in the figure; then by blowing through the extremity A although the paper may be bent from the orifice B if it is not without the influence of the wind, it will be bent up beyond the direction of the element (*a b*) of the quill and the extremity farthest from the orifice will be most elevated. In this case the wind removes a part of the pressure of the air, and it becomes necessary that the paper should be inclined in a direction opposite to the wind, until the force of the wind exactly neutralizes the pressure of the atmosphere on the opposite side, and since the force of the wind diminishes, as the distance increases, the paper should be elevated most, at the greatest distance from the orifice, so as to compensate for the diminished force, by the increased inclination. Also if the paper should be caused to make a greater angle with the direction of the wind, on account of the increased pressure on the opposite side, it would be depressed to the former position. If



we now have a current of wind passing through the quill (A B,) when it meets the surface (C D) it will have a tendency to pass off in a direction parallel to that surface, and thus form a constant current parallel to the card (C D,) and originating in the centre of the card. But the air will exert a pressure upon this current. To prevent this the card (H I) is placed near the extremity B, of the quill, then since it is known (Nat. Phil.) that "if a body moves in a fluid at rest, a motion will be given to the fluid in the direction which the body moves," the current of wind which passes from the centre to the circumference of the card in every direction will have a tendency to draw out the *natural atmosphere* which may be between the current and the card (H I,) the current will take the place of that atmosphere, and the cards will approach each other until the opposite pressures are equal, but if a force be applied to remove the card (C D) as it is removed, the space between the cards being increased, the current of wind is expanded, and that it cannot produce so great a pressure upon the inner surface as before, (a part of the pressure from the outer surface not being neutralized,) will be apparent. This will continue to be the case until the current becomes so much expanded that the force which it exerts upon the atmosphere, just as it leaves the space between the cards, is not sufficient to overcome the inward pressure of the air; for then the air will rush in and the disc (H I) will be separated from the other.

Amongst other experiments which appear favorable to the preceding explanation, the two following are submitted to your consideration. If the two cards are each about an inch in diameter it will be found rather difficult to produce the effect, but if the plane card remaining the same, the concave one is one and a half or two inches in diameter it may very easily be drawn towards the plane one ; if with the large card we use a plane one with the same radius, but having a segment cut from it, the concave disc, we shall find, will always have a tendency to slide over to the part where the plane disc is whole. These facts determined by experiment appear to be consequences of the explanation. If this should meet with your approbation you will favor me by inserting it in your Journal.

The current passing towards the card (C D) on the exterior side is hardly sensible, and appears far from sufficient to overcome the opposite pressure.

Yours respectfully,

Cadet Jas. H. Taylor.

7. *Zodiacal Light, Halos, &c.*

Remarks in a letter from Mr. David Leslie to the editor, dated New York, November 16th, 1828.

Sir—To my communication in the October number of your Journal, on atmospheric phenomena which I had supposed to be what has been called Zodiacal light, an editorial note appended classed those appearances under the head of Halos. On reconsidering the subject I am inclined to think that they are neither Zodiacal light nor Halos. Halos, I believe, are always lesser circles or arcs of lesser circles, whereas what I have endeavored to describe are luminous triangular beams terminating in a point diametrically opposite the sun, consequently in the plane of the zodiac and in which the prismatic colors are never seen. These triangular beams, like the Zodiacal light, form various angles at their apex, are of various lengths, and have their bases towards the sun. But their axes are not confined to the Zodiac. It appears that the Zodiacal light has not always been uniform in this respect, for Rees' Cyclopedia states that Mr. Derman, at Essex, England, saw it on the 3d of April, a quarter of an hour after sunset, perpendicular to the western horizon. This in that latitude must have made an angle of about 30 degrees with the Zodiac. It may be proper to observe that I never saw what is called *backstays* or *water drawers* at the same time with what I have described. The sun when above the horizon has been, I think, always unobscured. As to that seen in the water, the beams of light and shade are caused, I think, by the unequal refraction of the sun beams through the uneven surface of the sea, reflected by the opaque particles from which sea water is never free. This differs widely from the Iris, or marine bow, which may generally be seen in broken water or spray when the sun shines, making an angle like the rainbow of 139 degrees at the eye of the spectator with the broken water.

My former communication must be considered as only a description of appearances before (at least to me) undescribed and unexplained.

8. *Leather sheathing for ships.*—Major Howard, boarding officer of all foreign vessels at New York, has forwarded to the editor, through Mr. G. S. Silliman, one of the inspectors of that port, some barnacles and muscles, taken from the bottom of the ship Atlas. This ship, owned by Mr. Chase, was fitted out about twenty two months since, on a whaling voyage, and sheathed with leather. In some instances, the barnacle adhered directly to the bottom of the ship; in others, the muscle took the first place, and the barnacle mounted upon the muscle. In both instances, the neck or prominent and animal and consequently exposed part of the barnacle seems to have been assailed either by external friction, or by fish, and its shell left; viz. its interior, as a cell for the residence of some foreign inhabitant. From some of these cells, Major Howard extracted fish, of the largest class of minims, specimens of which will be forwarded to you. As this ship returned in an uncommonly foul condition, the impression is, that this mode of sheathing will disappoint the favorable anticipations of its projectors; as is evinced at least, in the estimation of Mr. Chase, in his now dismissing the leather, and substituting the customary material of copper.

9. *Earthquakes on the Mississippi; extracted from the travels of Mr. Flint.*

"From all the accounts, corrected one by another, and compared with the very imperfect narratives that were published, I infer that the shock of these earthquakes, in the immediate vicinity of the center of their course, must have equalled in their terrible heavings of the earth, any thing of the kind that has been recorded. I do not believe that the public have ever yet had any adequate idea of the violence of the concussions. We are accustomed to measure this, by the buildings overturned, and the mortality that results. Here the country was thinly settled. The houses fortunately were frail and of logs, the most difficult to overturn that could be constructed. Yet as it was, whole tracts were plunged into the bed of the river. The grave-yard at New Madrid, with all its sleeping tenants, was precipitated into the bend of the stream. Most of the houses were thrown down. Large lakes of twenty miles in extent were made in an hour; other lakes were drained. The whole country to the mouth of the Ohio in one direction, and to the St. Francis in the other, including a front of three hundred miles, was convulsed to such a degree as to create lakes and islands, the number of which is not yet known,—to cover a tract of many miles in extent near the Little Prairie, with water three or four feet deep; and when the water disappeared, a stratum of sand of the same thickness was left in its place. The trees split in the midst, lashed one with another, and are still visible over great tracts of country, inclining in every direction, and at every angle to the earth and to the horizon.

They described the undulations of the earth as resembling waves, increasing in elevation as they advanced, and when they had attained a certain fearful height, the earth would burst, and vast volumes of water and sand and pit-coal were discharged, as high as the tops of the trees. I have seen a hundred of these chasms which remained fearfully deep, although in a very tender alluvial soil, and after a lapse of seven years. Whole districts were covered with white sand, so as to become uninhabitable.

The water at first covered the whole country, particularly at the Little Prairie; and it must have been indeed a scene of horror, in these deep forests, and in the gloom of the darkest night, and by wading in the water to the middle, to fly from these concussions, which were occurring every few hours, with a noise equally terrible to the beasts and birds, as to men. The birds themselves lost all power and disposition to fly, and retreated to the bosoms of men, their fellow-sufferers in this scene of convulsion. A few persons sunk in these chasms and were providentially extricated. One person died of fright. One perished miserably on an island, which retained its original level, in the midst of a wide lake created by the earthquake. The hat and clothes of this man were found. A number perished who sunk with their boats in the river. A bursting of the earth, just below the village of New Madrid, arrested this mighty stream in its course, and caused a reflux of its waves, by which in a little time a great number of boats were swept by the ascending current into the mouth of the *Bayou*, carried out and left upon the dry earth, when the accumulating waters of the river had again cleared their current. There were a great number of severe shocks, but two series of concussions were particularly terrible, far more so than the rest. They remark that the shocks were clearly distinguishable into two classes; those in which the motion was horizontal, and those in which it was perpendicular. The latter were attended by the explosions and the terrible mixture of noises, that preceded and accompanied the earthquakes, in a louder degree, but were by no means so desolating and destructive as the other. When they were felt, the houses crumbled, the trees waved together, the ground sunk, and all the destructive phenomena were more conspicuous. In the intervals of the earthquakes there was one evening, and that a brilliant and cloudless one, in which the western sky was a continued glare of vivid flashes of lightning, and of repeated peals of subterranean thunder, seemed to proceed as the flashes did from below the horizon. They remark that this night, so conspicuous for subterranean thunder, was the same period in which the fatal earthquakes at Caraccas occurred, and they seem to suppose these flashes and that event parts of the same scene.

The people without exception were unlettered backwoods-men, of the class least addicted to reasoning. And yet it is remarkable how ingeniously and conclusively they reasoned from apprehension sharpened by fear. They remarked that the chasms in the earth were in direction, from south-west to north-east, and they were of an extent to swallow up, not only men but houses, 'down quick into the pit;'

and these chasms occurred frequently within intervals of half a mile. They felled the tallest trees at right angles with the chasms; and stationed themselves upon the felled trees. By this invention all were saved; for the chasms occurred more than once under these trees."

10. *New Instrument for drawing the curves of Conic Sections.**

(See the annexed plate.)

A B C is a block of wood, but little larger than the drawing, to which is screwed, the brass plate *d d* having the plate D D attached to it by the hinge *e e e*. This plate may be placed at any angle of elevation, and fixed in its position by means of the brass slides passing over the quadrants Q Q and tightened by the screws *s s*. The piece *m m* is screwed to the plate D D, and is perforated at *o*. Through this hole traverses the rod *r p* a foot in length, and about a quarter of an inch in diameter, highly polished; the other end of the rod, to which the pencil *p* is attached passes through the circular opening *g g* in the plate D D.

Now, if while one part of the rod is through *o*, the other is moved round the circle *g*, it is plain that the revolution will form a cone, and (while the plate D D is in the position represented in the figure) the pencil will describe an ellipse upon the plane *x x*. By varying the inclination of the plate D D, the axis of the cone will form every possible angle with the plane, and of course the four curves, in all their varieties, may be drawn.

It is not supposed that this instrument can be of much practical use, because each one of the curves separately, can be more easily and conveniently drawn by some method peculiar to itself. This is offered only as a mode which may

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* To the Editor.

Amherst College, Nov. 26, 1828.

Sir—Prof. Hitchcock requested me some time since, to send to you, for the Journal, a figure and description of a little instrument, which I had contrived for drawing the curves of conic sections. I have been postponing a compliance with this request, on account of a practical difficulty in the construction of the instrument, which I have not until lately remedied. The following drawing and description is now at your service.

With much respect yours,

J. Abbott.

be interesting to the scholar, as it draws them all upon a uniform plan, and that depending only on the simple principle of the intersection of a cone and a plane.

11. *Description of the Polariscope, an instrument for observing some of the most interesting phenomena of Polarised Light, invented by* H. J. Brooke, Esq. F. R. S. &c.; communicated by Prof. J. W. Webster.

The term *polarised* light has been derived from one of the two principal theories concerning the nature of light.

One of these theories supposes the sensation of light to be produced by the undulations or vibrations, continually succeeding each other, of a very subtle medium, which exists among the particles or within the pores of the hardest bodies as freely as it does in space. And light is thus conceived to be in some measure analogous to sound.

The other theory supposes light to be material, and to consist of minute solid particles, of each of which two opposite sides or ends, as they may be familiarly termed, are endued with peculiar properties, and hence, from an imaginary analogy to the poles of a magnet, have been denominated *poles.*

It is well known that when light falls obliquely on the polished surface of a transparent body, as glass, one portion of it is reflected from that surface, and another portion is transmitted, or passes through the body.

Thus a portion of the light from the sun which falls on a window, is reflected, and another portion enters and illuminates the room.

It has been found that when light falls *at a particular angle* upon the polished surface of a transparent body, (*this angle however being different for different bodies*) both the reflected and transmitted portions acquire new and highly interesting properties totally distinct from those of common light. This change of character is conceived to be produced by the manner in which the particles of light become arranged at the instant of their separation into two portions; the *poles* of *all* the particles of the reflected portion being then supposed to point in one direction, and those of the transmitted portion in another. When the particles of light have been subjected to this supposed regular arrangement, the light is said to be *polarised.*

The term *polarisation* thus derived from the corpuscular theory of light, has also been adopted as a convenient term by those who support the theory of undulations.

Light is also found to be *polarised* by transmission through some transparent bodies, in the same manner as it is by reflection from others. And when light so polarised is made to pass through transparent crystallized substances, some of the most splendid phenomena in optics are produced.

The small instrument which is represented in the annexed Plate, will exhibit many of these phenomena, and will enable the enquirer in this branch of science to make new experiments.

Fig. 1st. shews the instrument when put together for use.

Fig. 2d. shews the principal parts separately, the one marked *a*, the other *b*.

Fig. 3d. is the part contained within *b* that is moveable by means of the small external pin *i*, and to which is attached the revolving plate *d*.

When the instrument is to be used, the two parts *a* and *b*, fig. 2, must be placed as they are represented in fig. 1, and the lines marked *e* in the figures 1 and 2 are *always* in the first instance to be made to coincide. The pin of the moveable piece, fig. 3, should also be brought home to the line at *c*. This position however of the pin, and the relative positions of the lines *c*, will be continually changing while the instrument is in use.

The small revolving plate *d* has one hole uncovered and five covered with different bodies; these are attached with cement, and may be removed if the holes they cover should be wanted for other experiments.

The phenomena of *polarisation* may be conveniently observed in the following order:

Let the uncovered hole of *d* be called hole 1, the next longest hole 2; and so on. By means of the pin on the revolving plate *d* bring hole 1 over the aperture in the centre of *b*, and then place *a* in *b* as before directed. Holding the instrument now between the eye and the light, look through the hole at the *bottom* of *b* and very little light will be perceived. But if while the instrument is held to the eye the tube *a* be gradually moved round so as to bring the line at *c* to coincide successively with the other lines on *b*, more light will gradually appear, and when *a* has been moved through a quarter of the circle the light will be at its maximum. If *a* be further turned round the light will now decrease, and when *a* has moved through another quarter of the circle the light will be as much reduced as it was when the lines at *c* coincided.

Light may be seen through the aperture in either *a* or *b*, when these are looked through separately. But as we observe that there is one relative position of *a* and *b* when they are together in which the light that has passed through *a* does not pass through *b*, it is evident that it has undergone some change in passing through *a*, and is no longer ordinary light; and by examining its new properties it is found to have been *polarised* by passing through *a*.

Now bring hole 2 of the plate *d* over the hole of the instrument, and put the instrument together as already directed, and while looking through the aperture at the bottom of *b*, move fig. 3 gradually round by means of the external pin, and it will be found that the light is alternately restored and extinguished as the pin is moved round. Hence the fragment of carbonate of lime, split parallel to its natural planes, which covers hole 2, is found capable, in certain positions, of altering the property the light has acquired in passing through *a*, or in the language of most authors on this subject of *depolarising* it.

It is not intended here to enter into the theory, or into the details of the phenomena of polarisation further than is necessary for explaining the few terms about to be used, and without which those terms could not be at all intelligible. Transparent bodies may in reference to their action on light be divided into *two* classes. In *one*, the rays of light which pass perpendicularly through them proceed always in *single straight lines*. These are said to possess only *single refraction*.

In the *other* class, the rays which penetrate the bodies, are divided at their entrance into two portions, which pass in two diverging straight lines through the substance. These portions at their emergence are found to have become polarised, and to have acquired contrary states of polarisation, so that one portion of each divided ray, possesses properties similar to those of light which has been polarised by reflection, and the other portion has become similar to that light which has been, as before described, polarised by passing through a reflecting surface after falling upon it at the *polarising* angle.

Substances which possess this property of *dividing* the rays that pass through them, are said to be *doubly refractive*, and these are, generally, crystallized bodies, or such as have their particles symmetrically arranged.

It must however be observed, that some *doubly refracting* bodies, possess that property in so slight a degree, as not to be sensible to ordinary direct observation.

It is also found that the property of *double refraction*, does not exist equally, in every direction in the same crystal. But that there is one direction in some crystals, and in others there are two directions, in which if light be perpendicularly incident, upon planes perpendicular to those directions, no division of the ray takes place in its passage through the crystal. These directions are termed the *optic axes* of crystals, or their *axes of double refraction*. When double refraction takes place in every direction but one, the crystal is said to possess a *single axis*. When there are two directions in the same crystal, in which *double refraction* does not take place, the crystal is said to possess *two axes;* and these are always found to lie symmetrically on each side of some particular crystallographical line within the crystal.

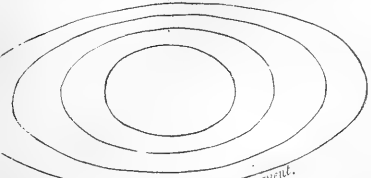
Hole 3 of *d*, is covered with a specimen of carbonate of lime, and hole 4 with one of quartz, each of these having only a single axis, and both being cut perpendicular to that axis. Hole 5 is covered with a specimen of nitre, and 6 with one of arragonite, both of which have *two axes* of double refraction.

Fig. 4, is intended to shew the relative positions of the axes, in different crystals, with one and two axes. When a crystal has only a *single axis*, its optical character may be observed by looking *perpendicularly* through the instrument, as in the direction *e f*. But where there are *two axes*, these may lie near together, as *g f*, *f g*, or they may be further separated, as at *h f*, *h f*. Where the angle *g f g* is small, as in nitre, the phenomena of the two axes may be observed at the same time; but where the angle, as *h f h*, is greater, as it is in arragonite, the instrument must be held aslant, first on one side, and then on the other, to observe the phenomena of both the axes.

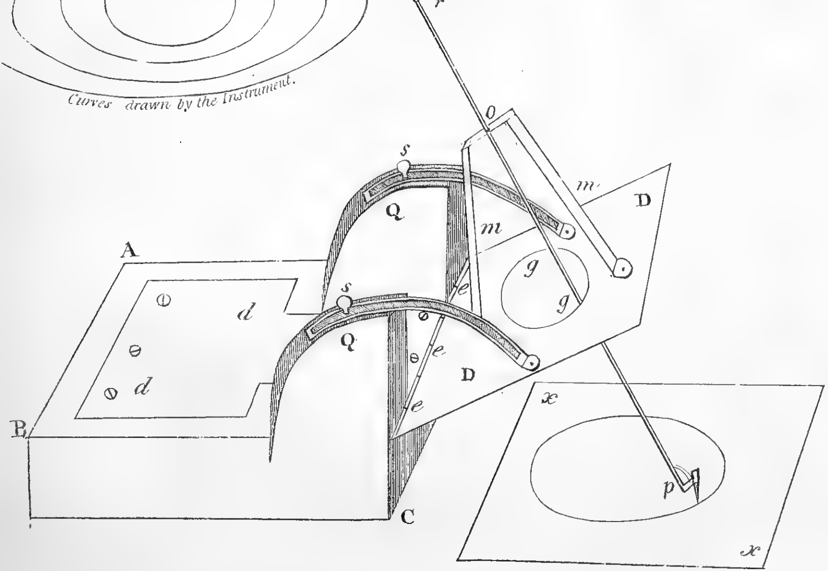
The phenomena exhibited may be varied in an interesting and beautiful manner, by turning round either the moveable part, fig. 3, by means of the external pin, or the tube *a*, or by varying the relative positions of both.

As an investigation of these phenomena would involve some of the most abstruse and difficult problems in the theory of light, it will not be attempted here, but the reader is

Curves of Conic Sections.



Curves drawn by the Instrument.



Polariscope for Polarised Light.

Diameter of a 1 $\frac{8}{10}$ inch
Depth . . . . $\frac{1}{2}$ inch

Fig. 1.

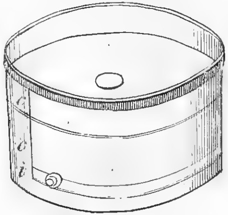


Fig. 2.

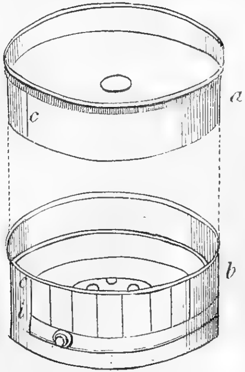


Fig. 3.

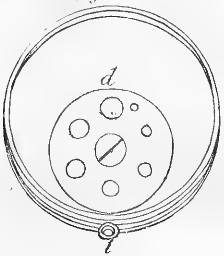
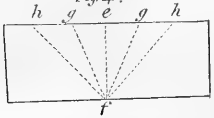


Fig. 4.



A. Doolittle sc

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referred to the Philosophical Transactions, the Transactions of the Cambridge Philosophical Society, the Traité de Physique by Biot, the article Optics in the Edinburgh Encyclopœdia, and the article Light in the Encyclopœdia Metropolitana; this last is not yet completed, but from what has been published, it appears to be the most full and accurate treatise on the subject, that has yet appeared. There are also many interesting papers on polarisation in several of the English and foreign periodical journals.

12. *Progress of the American Post Office Department.*—With the report from the Postmaster General is exhibited a comparative view of the gradual increase of that establishment, from five to five years, since 1792 till this time, in the number of Post Offices, which has grown from less than two hundred to nearly eight thousand; in the revenue yielded by them, which, from sixty seven thousand dollars, has swollen to upwards of a million and a half, and in the number of miles of Post Roads, which, from five thousand six hundred and forty two, have multiplied to one hundred and fourteen thousand five hundred and thirty six. While, in the same period of time, the population of the Union has about thrice doubled, the rate of increase of these offices is nearly forty, and of the revenue and of travelled miles from twenty to twenty five for one. The increase of revenue, within the last five years, has been nearly equal to the whole revenue of the department in 1812.

The expenditures of the department during the year which ended on the first of July last, have exceeded the receipts by a sum of about twenty five thousand dollars. The excess has been occasioned by the increase of mail conveyances and facilities, to the extent of near eight hundred thousand miles.* It has been supplied by collections from the Postmasters, of the arrearages of preceding years. While the correct principle seems to be, that the income levied by the department should defray all its expenses, it has never been the policy of this government to raise from this establishment any revenue to be applied to any other purposes. The suggestion of the Post Master General, that the insurance of the safe transmission of monies by the mail, might be as-

* Viz. the whole amount of additional miles travelled by the mail, reckoning the travelling of all the days of the year in one aggregate.

sumed by the Department, for a moderate and competent remuneration, will deserve the consideration of Congress.—*Message of the President of the United States, Dec.* 1828.

13. *American Blistered Steel.*—From a printed notice which we have received, supported by numerous and decided certificates, it appears that excellent blistered steel is now manufactured by the American Eagle Company, whose reference is to Townsend, Titus & Co. 299 Pearl street, New York. The artists who have borne witness to the excellence of this steel, have manufactured it into cutting instruments, both coarse and fine, and find that in firmness and strength, in delicacy and permanency of edge, and in brilliancy of polish, it is equal to the best English blistered steel.

14. *Notices of Palestine, &c. in a letter from the Rev. J. Bird to the Editor, dated Lazaretto Rooms, Malta, June* 20, 1828—*received Oct.* 7.

Dear Sir—I was not long since reminded in a letter from the Rev. Mr. Brewer, that you were expecting a few more mineralogical specimens from Syria, *according to promise.** Indeed sir, I had not forgotten the promise nor relinquished the intention of fulfilling it. Were it otherwise, you would have had an earlier reply to your obliging favor of March, 1826. I intended that the fulfilment and the reply should come to you together. But if you have found time to keep a little watch of our motions, you will have observed that, for the last two years, I have hardly been without the precincts of Beyroot. I have had, during this period, so much more to do with *men* than with *things*, that nothing of special interest, connected with your departments of science has fallen under my observation. Quite lately, however, I have been a little more abroad, and have not failed to improve the opportunity to collect together all things within my reach which I supposed would be acceptable to you. This collection I now send you.

Of the former box, sent two years ago, I have not had a word of history except from yourself. How it should have been opened on the way, and its contents put into such a state of confusion, I am, of course, unable to explain. Per-

* The boxes referred to, by Mr. Bird, arrived, while this proof was passing through the press and there has been no time to examine them; they may be noticed hereafter.—Ed.

haps it was fallen in with by some of our troublesome neighbors, or perhaps some one else, thinking from its weight, that it might contain more "*precious* stones" than such as may be picked up every day by the way side, found his curiosity excited beyond the power of resistance. However, it was well that the box reached you at all. I am disposed to think that few of the articles were taken quite away, but some of them must have been rendered worthless from the loss of their labels, and others more than worthless by having their labels exchanged for such as did not belong to them. If any of these specimens have been thought worthy of a place in your cabinet, it is desirable that their labelling should be correct. For this purpose, I beg leave to offer a few remarks, such as have suggested themselves to me from an attentive perusal of your list of notices. As you doubtless have that list at hand, by recurring to it you will easily understand me. No. 3*, is called an animal relic of a convoluted form, from the Dead Sea. Now these relics, I suspect, are, in this quarter, peculiar to Mount Lebanon; whereas one of the specimens at least, which I brought from the locality mentioned on the label was of a class resembling the volcanic. No. 14. Both these pieces from the Holy Sepulchre should have been white. The black one had got out of its place. No. 15. "Gethsemane and the Holy Sepulchre" are certainly no places for petrified shells, nor can I recollect any one specimen sent that could have been common to the two localities. These words were perhaps originally written on an envelope, containing other labels with their specimens within. Of Gethsemane the characteristic stone is flint or horn stone, of which there is a profusion, similar to Nos. 27, and 40. The word "Holy Sepulchre" must have meant the *church* of the Holy Sepulchre, and the fragments intended were very likely two or three little hemispheres of red marble of the size of musket balls, quality of Nos. 16, 34, and 35. Pieces of this kind, I remember, were, among others, broken off by our servant, unbidden, from an ornamented part of the church. The beryl, No. 31, is doubtless a specimen which was presented me by a young Swiss traveller. It came from some of the mountainous parts of Egypt. I fear also that the label, No. 36, had been misplaced upon a Mount Lebanon shell. It may be, however, that Gornoo produces such petrifactions. The Egyptian specimens hav-

* See Vol. X., p. 21 of this Journal.

ing all been given me by others, I do not recollect them well, and cannot be positive respecting them. The Arragonite, No. 42, I have little doubt, was sent me by a friend in Cyprus. If I am right in this the specimen must be of a loose, friable structure, and in size and shape not very remotely resembling the hand. As to the remaining labels I think I can pronounce them to be correct.

The red marble of Jerusalem admits of an elegant polish. That of the "*mouth piece*," I sent you (No. 16) is not by any means a good example of it. When thus polished, its variegated structure is brought into view with so much advantage that little slabs of it are set in snuff boxes, &c. in place of the more precious stones. This species of marble exists in considerable beds at Hebron and in the region of Jerusalem, not to speak of other places, but at present it seems not to be quarried. It is not so valuable for building, being weakened by loose intersecting veins, yet you may find broken columns of it in almost every city. The "Prophet Jonas," (No. 24,) is the mere English of Nabi Jonas; (see No. 39.) It is the place, you will recollect, where the Moslems say that that prophet was thrown upon the shore by the fish.

No. 27. "Frank" or French "Mountain" is called by the natives Gebel Fransa-wy, and Gebel Ferdees. It is supposed to be the Herodium of Josephus. Whoever surveys the landscape from the Mount of Olives and more especially from "the heights of Bethlehem" cannot avoid marking this hill as one of the most interesting objects before him. Its sides rise with so equal a slope, its top is so unnaturally regular, hollowed in the center and bounded by an even brim like the crater of a volcano that it is a subject of wonder how any traveller, either scientific or curious, should ever visit Jerusalem without satisfying himself about it. And yet one who possessed these qualities it should seem in no humble degree, has lately ventured to give out the singular conjecture that this hill is a volcano. A little inquiry of the natives of Bethlehem would be sufficient to convince any one that it is not so. I visited it in company with Mr. Fisk in 1824 and we discovered not the remotest signs of a volcano. Of its minerals, the hornstone I sent you is as characteristic as any. That this is the same hill which the traveller in question had in view in his remarks, is certain, from the fact that, though it is not near the Dead Sea as he supposes, it is nevertheless in the very same direction, conical, and crowned with a crater "plainly discernible," and the only one visible from Bethlehem that at all answers this description.

Your remark on No. 30 gives me the opportunity of saying that whoever expects to see a proper *pebble* from the brook Cedron, i. e. a stone bearing any strong marks of attrition, will expect in vain. For the gratification of a few friends I would gladly have gathered a few handfuls of such pebbles, but I traversed the whole dry bed of the brook down to the Pool of Siloam and could not find one. The truth is that this bed, above the bridge (near Gethsemane) is so broad and flat as to be regularly ploughed and sown, and below the little quantity of water that passes during the heavy showers of winter is barely sufficient to clear away the rubbish of the city which either falls in from the perpendicular banks or is brought in by the passing of animals and men. The pebbles of Cedron are fragments of pottery. Far below the city, however, the case is different, for here the little insignificant Cedron assumes a more important character, and in making to itself a passage through the mountains to the Dead Sea, it has cut out one of the most frightful chasms I have ever seen.

On looking over the "Description of Minerals from Palestine, by Prof. Hall," I am sorry to find from the pen of Mr. Fisk an expression so incautious as that of label No. 6. Mr. F. doubtless had in mind the expression of the Evangelist, (Luke iv. 29.) but contenting himself with a mere *allusion* instead of a *strict quotation*, he has changed the sense of the passage and left an impression about the situation of the "city" of Nazareth, which he would by no means have done had he considered himself as giving a topographical description of the place. Luke does not say that Nazareth was *built on the brow* of a hill, much less on that of a precipice, but only that it was built on a "mountain" (του ορους.) The brow or precipice may have been, and probably was, a mile off.* See Jowett's Researches on this particular.

I have only a word to add with regard to the present box. It contains too little variety to meet your probable expecta-

* I fear the same author's speculations about the identity of our Savior's sepulchre and about the remarkable "Crypt" on the Mount of Olives, are to be received with equal caution. This Crypt is in no way different from the common cisterns of the country for the reception of rain water.

tions. The collection was made chiefly from the productions of Lebanon, during my visit there with my family last summer and autumn. Among the most interesting of the whole I reckon the oyster shells. They enclose, as you will see, what seems to be a part of the animal itself in a petrified state. They are from the only locality of the kind of which I have any knowledge in the country. It is a plat of cultivated ground, fifteen or twenty yards square, surrounded on three sides by high limestone rocks, and at an elevation above the sea of perhaps one thousand feet. The oyster seems to be at present quite unknown in Syria. I have not been able to obtain any more of the petrifactions of fish,* but they may be easily obtained hereafter. The cedar ball is said to possess the power of reproduction when properly planted. We are assured that fine cedars are now growing in England, produced from the seed of the Besharry grove. If this be true, I hope you may yet live to see your own dwelling shaded by cedars of Lebanon.

15. *Notice concerning the Horticultural Society of Paris, translated for the American Journal of Science; by Jacob Porter.*—The Horticultural Society of Paris, was instituted for the encouragement and perfecting, in France, of the various branches of gardening.

Gardening is both a science and an art. It embraces the knowledge and use of all the elements of the vegetable kingdom, that serve or may serve the wants as well as the pleasures of mankind, and that have not already been brought forward in full by agriculture.

This definition, precise and rigorous, must give an exact idea of what is, at present, understood by horticulture, the culture of the garden, a new term, becomes necessary, since, in the course of language and the decline of words, the terms of gardening and gardener, suggest to the mind of the proprietor, little more than the enclosure and the laborer employed in the regular culture of his fruits and pulse.

Horticulture, on the contrary, comprehends, in its natural and methodical divisions,

1. The nursery, or the first training of useful or pleasing vegetables;

2. The orchard and kitchen garden, containing the fruits and pulse destined for the nourishment of man;

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* From twenty miles north of Beyroot. See Vol. X. p. 28, of this Journal.

3. Economical and medicinal plants, an abundant, never failing source, from which the arts, medicine and even agriculture are constantly drawing;

4. Ornamental plants, which are divided into such as flower in the open air, either annual or perennial, for the decoration of pleasure grounds and groves; and exotics, that require the shelter of green houses or hot houses;

5. Parks and landscape gardens, establishments, that are connected, at once, with the observation of nature, the study of the arts, and likewise with the knowledge of the human heart, if, as is intended, they throw any charm around our transitory dwellings.

Each of these divisions deserving, in order to be well treated, particular attention, and requiring peculiar skill, the Horticultural Society has appointed from among its members, a committee on nurseries, who are occupied in the culture and improvement of fruit trees; a committee on kitchen gardens; a committee on economical and medicinal plants; a committee on ornamental plants, growing either in the open air, green houses or hot houses; and a committee on the composition of gardens.

The society has likewise given to its own labors and to its correspondence, a more precise direction, and furnished some results, that might be truly valuable.

These committees, with whom are associated a committee of the funds, a committee for publishing the Annals, and the officers properly so called, compose a council of administration, that meet twice a month. They direct the labors of the society, the employment of the funds, and every thing that relates to the administration.

They propose and encourage the making of experiments, and the attempting of new methods of culture.

The members of the society share in the useful results, that they obtain by their efforts.

The council carry on a correspondence with all the horticultural societies; they communicate to them, and in their turn, receive all the instructions, that may concur to the progress of the art.

They request explanations concerning the most remarkable productions of horticulture, and determine the soil and the times, that promote their growth.

They call together, at least once a year, the members of the society in a general meeting, to present the account of their labors, and that of their receipts and expenditures, as likewise to propose and distribute prizes or give medals of encouragement.

The general secretary is particularly charged with making the report, to the general meeting, of the labors of the society, and of conducting the correspondence with learned societies.

The progress and perfection of the art being founded on experience and observation, the society will take measures to procure at Paris or in its environs, a garden, where it will be able to verify facts, to make essays concerning the culture of useful or ornamental plants, and observe the new species, that may be received from distant countries so as afterwards to distribute them in France, according to their qualities. The formation of this garden depends, in a great measure, on the state of the society's finances; and its great utility is so incontestable, that it does not fear urgently to solicit the subscription of all such as feel interested in the prosperity of their country. The moderate subscription, fixed at thirty francs a year, is, in some degree, compensated by the journal, which it publishes monthly, and which is distributed gratuitously to all the members.

The annals of the Horticultural Society, which must become the depository of all the facts, all the experiments, all the inquiries, and all the writings relating to horticulture, ought to be, at the same time, the bond, that shall unite, in heart, spirit and labor, with the council of administration residing at Paris, all the members of the association scattered through the different parts of the kingdom. For it is not necessary that these members should be regarded as subscribers merely because they do not actually form part of the council of administration. Each member of the society is alike one of its fellow laborers. Whenever they visit Paris, it is their duty, it will be for their interest, and we flatter ourselves that it will enter into the arrangement of their pleasures, to assist at the meetings where they will have the privilege of debating, and the times for which will, for this purpose, be regularly pointed out on the cover of each number of the Annals; and all, in whatever direction, and at whatever distance they may be situated, to whatever branch of horticulture they may devote their studies or their labors, are alike invited to a co-operation, which will be so much the more beneficial as it shall be the more universal. All are, therefore, requested to address the results of their observations and experience to the general secretary at Paris.

The true friends of fine culture, of every thing, that meliorates the condition of man, will soon felicitate themselves on seeing thus united in a brilliant constellation, the ideas, the essays, the theories, the experiments, the very proposals, that may sustain, in its yet uncertain march, an art, which appears to some altogether new, though it must have been as early as agriculture; an art, the value of which being more sensibly felt, the charms better relished, the practise more diffused, could not, we venture to say, be without some influence on the tranquillity of the state, seeing horticulture opens to the view of rural proprietors a source of unknown blessings, which render more attractive the residence on their domains, and seeing it attaches man to the earth by the ties of flowers. The English have given the example and the impulse; and the Annals of their Horticultural Societies now present before us, acting in concert, marching in front, and rivaling each other in zeal, some of the learned, of their philosophers and statesmen descending to the culture of the fruits and leguminous plants, and of simple gardeners elevating to the excellence of the finest theories, their minds already strengthened by the practice and habit of observation.

It is impossible that the French should remain in the rear. They have in their favor their sky, their soil, their climate, their government, and that national sensibility, which leads them patiently to search out whatever is good and fine. Horticulture, therefore, will be their delight.

Chevalier SOULANGE-BODIN, *General Secretary.*

16. *Method of preserving fruit without sugar.*—You must use wide-necked bottles, such as are used for wine and porter. Have the bottles perfectly clean. The fruit should not be too ripe. Fill the bottles as full as they will hold, so as to admit the cork going in. Make the fruit lie compact; fit the corks to each bottle, slightly putting them in that they may be taken out the easier when scalded enough; this may be done in any thing which is convenient; put a coarse cloth of any kind at the bottom of the vessel, to prevent the bottles from cracking; fill the vessel with water sufficiently high for the bottles to be nearly covered in it; turn them a little

one side to expel the air that is contained in the bottom of the bottle; then light the fire; take care that the bottles do not touch the sides nor the bottom of the vessel, for fear they will burst, and increase the heat gradually, until the thermometer rises to 160 or 170°. If such an instrument cannot be procured, you must judge by the finger; the water must not be so hot as to scald. It must be kept at that sufficient degree of heat for an half hour; it should not be kept on any longer, nor a greater heat produced than above mentioned. During the time the bottles are increasing in heat, a teakettle of water must be ready boiled as soon as the fruit is done. As soon as the fruit is properly scalded, take the bottles out of the water one at a time, and fill them within an inch of the cork with the boiling water. Cork them down immediately, doing it gently but very tight, by pushing the cork in, for agitation will be apt to burst the bottles; lay the bottles on the side, to keep the air from escaping. You must take care to let them lie on their sides until wanted, often turning them over, once in a week or once in a month.

17. *Miscellaneous Notices in Letters to the Editor.*

"Rome, Dec. 6, 1827.

"We proceeded to Hanover, Hamburg, Kiel and Copenhagen, at which last place we spent some time. It is a clean, pleasant town, and remarkably quiet; no great proof of its prosperity. In truth it seems to have very little commerce, and that little does not increase. Some large warehouses built for the purposes of trade, are now used as granaries by the government. As they cannot be filled with goods brought from the Indies, they are filled with corn received for taxes, in lieu of specie, of which there is very little in the country. According to all that I could observe, there must be very little opportunity to acquire wealth in Denmark, but the means of learning are not wanting. We visited an excellent reading-room, where, in a choice collection of valuable works from abroad, I was pleased to see the American Journal. At the museum of the university a large number of Runic antiquities were shown us. When we recollect how the Scandinavians extended their conquests and their colonies over Europe, and especially how many of them, under the different names of Danes and Normans, became mingled with the older inhabitants of our parent country, we may reasonably consider them as our ancestors; and it was not a little interesting to see the knives, and arrows, and hatchets, which they made of flint before the metals were known among them, and when of course they were as wild as the savages of our own forests. These implements, and many others of various kinds, have been dug out of the barrows, which are very numerous on the island of Zealand. We sometimes had as many as twenty of these mounds, at once, within our circle of vision.

From Copenhagen we went to Roeschild, the ancient capital, and present burial place of the Danish monarchs. It retains little magnificence, with the exception of that which is seen in the cathedral. The tombs of the royal family contained in this church are as rich and splendid, as any that I recollect to have visited. At Elsineur we enjoyed the magnificent spectacle of the Russian fleet passing the sound. In a few days you will be delighted with the intelligence of the memorable victory, which, in conjunction with those of France and England, it has gained over the murderers of the Greeks.

Having crossed the Sound at Elsineur, we went through a part of Sweden, to Ystad on the southern shore. We could not in a journey of two or three days learn much about the country or its inhabitants, but we saw many of the latter, and I have never been better pleased with the appearance of any race of men. Their robust frames and muscular limbs would form a fine contrast with the diminutive figures that one sees in the delightful but enervating regions of the South."

"London, August 5, 1828.

"Since I last wrote you I have passed over a considerable space, and seen a variety of interesting objects. I had the pleasure in the spring of witnessing a slight eruption of Vesuvius, 'slight' at least in comparison with former ones, but very magnificent in my eyes, to which it appeared one of the grandest sights I had ever beheld. In returning from Italy, I took a route very remarkable for its magnificent and romantic scenery. I came from Florence to Lucca, and thence along the coast to Nice; thence by the first carriage road made over the great Alps to Turin, and then over Mont Cenis to Chambery. Near Chambery I visited the Grand Chartreuse, the mother of the Carthusian convents all over the world. The house is said to have cost more than a million, and I can well believe it, for it is an immense pile, constructed of hewn stone, and situate on a mountain three thousand feet above the sea. It was the end of May or beginning of June when I was at the convent, but the snow still lay in one of the courts. The road up the mountain was one of the most romantic that I had ever seen, and the situation of the convent itself, surrounded as it is with forests and snow-crowned Alps, is wild and appalling. Here the monks wear out their days in prayer and fasting. Meat they must never touch, even to save life, and in the use of other food they are much restricted. I passed the night at the convent, but was compelled to quit it without breakfast in the morning, for no eating was allowed within the walls before noon. Silence and quiet are studiously preserved within this holy retreat.

I hope in a few weeks to embark for my native land. I have had much gratification in my long pilgrimage, and I quit the old world without regret, though my time has passed happily here, and I expect never to see these shores again. What I have seen abroad has confirmed me in the opinion that we are the most favored people on the face of the earth. I love our free institutions, and rejoice that our countrymen are sufficiently enlightened and moral to bear them. Here it must be otherwise for a long time to come. Even in this nation, so exalted in many respects above most others on this side of the ocean, there are turbulent elements, which need to be kept down by the strong hand of power."

18. *Remarks on the theory of a central heat in the earth, and on other geological theories; in letters addressed to the Editor, by William Maclure, P. A. G. S.*

I have perused the essay* on volcanos, in the American Journal. It is a regularly constructed theory, but founded on the supposition of the state of fluidity by heat, towards the earth's centre, which, in my opinion, is contrary to all our experience of the diminution of heat in proportion to the depth under the surface, as well as the freezing of the earth at all depths towards the poles, which being nearer the centre than at the equator, ought to be more influenced by the central heat. All these speculations are out of the reach of our senses, and can be counted only as amusement, until

* By G. Poulett Scrope, Esq.

utility becomes the scale of measurement of value, when all nations may agree to spend their unoccupied exertions in making a great excavation, as far towards the centre of the earth, as their means will permit them to go, when something may be discovered within the evidence of our senses, on which we can build conjectures that have some foundation in analogy.

Geology.—The vibration of the pendulum, seems the favorite motion of all speculative opinions, beyond the reach of our senses or the control of facts. While Werner gave the tone to geology, water was the only agent that nature dared to make use of, in her changes of the surface of our globe. Since his death, the Vulcanists seem to take their revenge, and in their purpose to bend the hoop straight, may perhaps go as far in the contrary direction; although the Neptunian marks of organic remains, will keep them within certain bounds, on all above the primitive, which will be smelted, roasted and liquified, as the only field of experiment they can occupy; the primitive having this in common with the volcanic, that no organic remains have been yet found, either in it or under it; this important fact may appear to give them latitude for conjecture. In my maturer years, I find myself averse to change, and do not think I could better the conjecture at the end of my small essay on the formation of rocks, that analogy might perhaps dispose us to place hornblende, greenstone, sienite, porphyry and granite, among the volcanic rocks, &c. One thing I thought I observed in more than one country, that rocks which by resemblance might be considered of volcanic origin, are found alternating with transition, secondary and alluvial, so that it would appear that both fire and water have been the agents that nature has employed to overlay the primitive, with all we find at present above it, and it would appear from the nature of the rocks ejected without being fused, that the seat of volcanic action is either in or below the primitive. Yet we dare scarce venture to limit natural agencies to one mode of producing any effect; for instance, earthquakes have been supposed to be connected with volcanic action, although the two or three shocks lately felt in this western country, seem to have arisen from other causes, as there is no appearance either of ancient or recent volcanos, in any part of the basin of the Mississippi, short of the Rocky Mountains. The effects as far as we know, have deranged nothing but the alluvial, and have been most severe where there was the greatest accumulation of alluvial. May not they have been caused by the evolving of elastic gases, arising out of the fermentation of large masses of vegetable matter, deposited during a long accumulation of the drift wood, from the great rivers? If so, is it not probable that these earthquakes will become more frequent every day, as the mass of fermenting matter increases?

Extracted from French and English Journals for this Journal, by *C. U. Shepard.*

19. *New Minerals.*

I. *Murchisonite*, described by Mr. Levy; a feldspar laminated substance with a peculiar nacreous cleavage, which does not belong to any of the varieties of feldspar hitherto examined, not being parallel either to any known modification of that substance or to any unobserved modification which might be derived by some simple law from its primitive form. It is composed of

Silica	68·6
Alumine	16·6
Potash	14·8
	100·0

It is found at Dawlish in the conglomerate of the new red sand stone.—*Philosophical Mag. and Annals of Philosophy, June*, 1827.

II. *Berthierite*, described by Mr. Haidinger, is an ore of antimony, occurring in elongated imbedded prisms with a single pretty distinct longitudinal cleavage. It consists of four atoms of sulphuret of antimony and three atoms of protosulphuret of iron. It is found at Chazelles in Auvergne, in a vein which promises to be very productive. Its color is a dark steel-gray, inclining to pinchbeck brown.—*Edinburgh Journal of Science, Oct.* 1827.

III. *Sternbergite*, described by Haidinger also. Fundamental form a scalene four sided pyramid. Cleavage highly perfect in one direction. Lustre metallic. Color dark pinchbeck brown. Streak black. Tarnish often violet blue. Very sectile. Thin laminae perfectly flexible. Hardness =1·0 . . . . 1·5, little superior to Talc. Sp. Gr. =4·215.

Generally several crystals are joined together in an irregular manner, being fixed to their support with one of their sides, so as to produce rose like aggregations and globules with a drusy surface. Massive varieties usually present the aspect of a coarse-grained mica.

Its locality is Joachimstal in Bohemia, and must have been found at rather a remote period, as the specimens were discovered in old collections. It is chiefly accompanied with ores of silver as the red silver, the brittle silver, &c.—*Brewster's Journal.*

IV. *Glaucolite*, described by Mr. Sokoloff in the Russian Journal of Mines. It is found massive, presenting traces of cleavage. The fracture is splintery and uneven; lustre vitreous; color lavender blue passing into green. It is translucent on the edges. Hardness =5·0 . . . 6·0. Sp. Gr. =2·721 Bergemann; =2·9 John. According to Dr. Bergemann it consists of

Silica - - - - -	54·58
Alumine - - - - -	29.77
Potash - - - - -	4·57
Lime - - - - -	11·08
	100·00

Before the blow pipe it melts with difficulty on the edge, but is soluble in borax and salt of phosphorus. It loses its color.

It occurs in compact feldspar and granular limestone, with talc, near Lake Baikal, in Siberia.—*Philosophical Mag. and Annals of Philosophy, December*, 1827.

V. *Oxahevrite*, described by Dr. Brewster, as occurring in acute octahedrons with a square base, having the angles at the base truncated by planes parallel to the axis of the octahedron, and equally inclined to the adjacent sides of the base, so as to form, when enlarged, the faces of a square prism. The color of the crystals is light-gray, leek-green, olive-green, and reddish-brown; they are nearly as hard as apatite, sp. gr. 2·218. Their general size is about one tenth of an inch in length; their surfaces are even but not brilliant. They cleave with some facility perpendicular to the axis, but in no other direction. According to Dr. Turner, it consists of

Silica - - - - -	50·76
Lime - - - - -	22·39
Potash - - - - -	4·18
Peroxide of Iron - - -	3·39
Alumine - - - - -	1·00
Fluoric Acid - - - -	a trace
Water - - - - -	17·36
	99·08

It is found in the hot spring of Oxhaver, in Iceland; it occurs in petrifactions, in which the wood has been replaced by calcareous spar, and more or less crystallized.—*Edinburgh Journal of Science.*

VI. *Isopyre*, described by Mr. Haidinger, designated, from ισος (equal) and πυρ (fire) in consequence of its resemblance to certain varieties of iron slag. It is said to have the appearance of obsidian also, only the lustre is less bright and glassy. It is found imbedded in a kind of granite in the west of Cornwall. It is destitute of crystaline structure, possesses a conchoidal fracture, vitreous lustre, grayish black and velvet black color occasionally dotted with red, and is opake, or slightly translucent on the thinnest edges. Brittle. Possesses a slight action on the magnetic needle. Hardness =5·5 ... 6·0. Specific gravity =2.912. It is composed of

Silica - - - - -	47·09
Alumine - - - - -	13·91
Peroxide of Iron - - -	20·07
Lime - - - - -	15·43
Peroxide of Copper - - -	1·94
	98·44

Philosophical Mag. and Annals of Philosophy.

VII. *Osmelite*, described by Prof. Breithaupt, of Freyberg. Its name is derived from οσμη (smell) and λιθος (stone.) Its color is grayish and yellowish white. It consists of thin prismatic concretions, stellularly arranged; highly translucent, and greasy to the feel. Its hardness owing to the fibrous structure is difficult to determine; it appears however intermediate between fluor and apatite. Sp. Gr. =2·792 to 2·833. It gives out in the common temperature of a room a clayey smell, which is increased by breathing on it, or when brought from a warm to a cold place. In the mouth it tastes like clay and appears as if it would dissolve like clay, but no change takes place.

It occurs superimposed on calcareous spar, mixed with datholite in veins in trachyte, near Wolfstein, on the Rhine. —*Ibid.*

VIII. *Hydrosilicite*, described by Dr. Keh, is found at Frankenberg, in Silesia in serpentine along with chrysoprase, opal, and pemelite. It is white, without lustre, feels greasy, translucent, fracture even, soft, does not adhere to the tongue, amorphous and appears to be composed almost entirely of pure silica and water.—*Ibid.*

20. *Analysis of Tourmalines.**—M. Gmelin divides the tourmalines into three groupes.

1. Tourmalines which contain lithia. Of these he has analysed three varieties:—I. Tourmalines of Rosna in Moravia: Sp. Gr. 2·96 to 3·02. II. Red Tourmaline of Perm in Siberia: Sp. Gr. 3·059 to 3·10. III. Tourmaline of a celandine green color, from Brazil: Sp. Gr. 3·079.

	I.	II.	III.	
Boric acid,	5·74	4·18	4·59	
Silex,	42·13	39·37	39·16	
Alumine,	36·43	44·00	40·00	
Oxidul-oxide of iron,	-	-	5·96	
Ox. manganese,	6·32	5·02	2·14	
Lime,	1·20	-	-	
Potash,	2·41	1·29	-	
Lithia,	2·04	2·52	3·59	with potash.
Volatile substances,	1·31	1·58	1·58	
	97·58	97·96	97·02	

2. Tourmalines which contain potash or soda, or both, without lithia, and without a remarkable quantity of magnesia. The following specimens have been analysed:—I. Black tourmaline of Bovey in Devonshire: Sp. Gr. 3·246. II. Black tourmaline of Eibenstock in Saxony: Sp. Gr. 3·123. III. Green tourmaline of Chesterfield, North America: Sp. Gr. 3·102.

	I.	II.	III.
Boric acid, - -	4·11	1·89	3·88
Silex, - - -	35·20	33·05	33·80
Alumine, - - -	35·50	38·23	39·61
Oxidul-oxide of iron, -	17·86	-	7·43
Protox. of iron, -	-	23·86	-
Ox. manganese, -	·43	-	2·88
Magnesia, - -	·70	-	-
Lime, - -	·55	0·86	-
Soda, - -	2·09	3·17	4·95
Loss by ignition, -	-	·45	0·78
	96·44	101·51	98·33

* A notice of the analysis of tourmalines, by Gmelin, was published in Vol. XIV. page 385, but without *the tables.* which present the results in a very striking form.

3. Tourmalines which contain a considerable quantity of magnesia. Four varieties were analysed. I. Black tourmaline of Kärengbucka, Sweden: Sp. Gr. 3·044. II. Black tourmaline of Rabenstein in Bavaria: Sp. Gr. 3·113. III. Black tourmaline of Greenland: Sp. Gr. 3·062. IV. Brown tourmaline of Saint Gothard.

	I.	II.	III.	IV.
Boric acid, -	3·83	4·02	3·63	4·18
Silex, - -	37·65	35·48	38·79	37·81
Alumine, - -	33·46	34·75	37·19	31·61
Magnesia, -	10·98	4·68	5·86	5·99
Oxidul-oxide of iron,	9·38	17·44	5·81	7·77
Ox. of manganese,	-	1·89	traces.	1·11
Potash, } - -	2·53	0·48	·22	1·20
Soda, }		1·75	3·13	
Lime, - -	0·25	traces.	-	0·98
Loss by ignition,	0·03	-	1·86	0·24
	98·11	100·49	96·48	90·89

The loss in the last analysis is very considerable, and M. Gmelin states that he knows not what to attribute it to.—*Annales de Chim. Novembre.*

21. *Botany of Brazil.*—The number of species collected in Brazil, and now in the hands of European botanists, is estimated at fourteen thousand; of which number not more than five hundred were known at the commencement of the present century.—*Bibliothèque Universelle, Novembre.*

22. *Hydrate of Silex.*—M. Schmitz, among a variety of opals, of whose characters and localities he gives an account, describes one found in the graphite mine of Pfaffenreith, which surpasses all the known varieties of this mineral in the proportion of water it contains, which equals more than a third of its weight. It forms druses or crusts of several lines in thickness in a decomposed gneiss. Its color is greyish or bluish white. It is translucent, and exposed to a bright light, is feebly opalescent. Before the blow pipe it instantly loses its transparency, and decrepitates. It contains

Silex, ... 63·91.
Water, ... 34·84.

Bul. Univer. Novembre.

Foreign Extracts, by Prof. J. Griscom.

23. *Chloride of Lime.*—A memoir on this substance, read before the Philosophical Society of Geneva, by A. Morin, furnishes several interesting details, among which are the following.

The action of heat upon the dry chloride, has been examined by several chemists, and among others, by Welter and Ure. M. Welter expelled from the chloride, a quantity of oxygen, equal to that of the chlorine which had combined with the hydrate of lime. Dr. Ure obtained by the application of heat, at first chlorine, then euchlorine, and finally oxygen, but in variable quantities. In repeating these experiments on chlorides made at different temperatures, cold and hot, I have, in some cases, obtained oxygen without any sensible mixture of chlorine, and in the same quantity from the two chlorides. At other times, I have obtained chlorine and oxygen in the same order as Mr. Ure, but without being able to affirm whether this gas was mixed or not, with euchlorine.

I have remarked that in applying a very mild heat to the chloride, we may obtain at first a notable volume of chlorine, and that by heating it rapidly, oxygen is immediately obtained, mixed with a very small portion of chlorine. It is very difficult to introduce any great precision in these experiments.

With respect to the liquid chloride—

When water acts upon dry chloride of lime, a portion of lime is separated, which may be left in contact with the fluid, or abstracted by filtration.

If a matrass, furnished with a tube, &c. for collecting gas, be filled with this fluid, some bubbles of air will immediately collect at the top of the glass. If it be heated, the production of them will be accelerated, some of the fluid will be driven into the receiver, and the gas will rapidly rise to the top.

As soon as it boils, the disengagement of gas becomes rapid, and continues with the same intensity about half an hour, then diminishes, and after some hours nearly ceases.

The gas is pure oxygen. If, instead of entirely filling the glass with the fluid, we leave at the top a space filled with air, and apply heat, the liquid remains, and we may estimate very exactly, the volume of oxygen which this quantity of liquid can furnish. The chloride of lime is reduced to nearly $\frac{1}{300}$ by ebullition. Thus during its fabrication, heat may destroy one third of its power of discoloration, and when dissolved, ebullition destroys the other two thirds.—*Ann. de Chimie et de Phys. Fev.* 1828.

24. *Ultra-marine.*—Gay Lussac announced to the French Academy on the 4th of February, that M. Guimet, his adjunct in the saltpetre and powder works, had succeeded in making ultra-marine of all varieties by combining the principles which by chemical analysis are found to exist in it. This new product has a richer and more splendid color than the natural lapis.—*Idem.*

25. *Heat of combustion.*—M. C. Despretz has discovered, by employing an improved calorimeter, that for every grain of oxygen absorbed, hydrogen disengages 2578 of heat.

Carbon - - - - - -	2967
Iron - - - - - -	5325

Phosphorus, zinc, and tin disengage quantities about equal to that of iron.

Hence, of all bodies, hydrogen is that which developes the least heat in absorbing the same quantity of oxygen gas.* The metals are those which disengage the most.

It is remarkable that carbon, which does not change the volume of oxygen gas, sets free a quantity of heat equal to three fifths of that which is liberated by iron and other metals. —*Ibid.*

26. *Force of chemical action.*—M. Babinet discovers that at the temperature of 77° F. the force with which hydrogen is disengaged from water, zinc and sulphuric acid, surpasses the pressure of 33 atmospheres.

At the temperature of 50° F. the action stops at a pressure of 13 atmospheres.

At common temperatures, chlorine disengaged by hydrochloric acid and oxide of manganese has an elasticity of about 2 atmospheres only.—*Ibid.*

27. *Evaporation by means of bladders.*—M. Sæmmering, in a memoir in the Academy of Sciences of Munich, states that alcohol, in a vessel covered with bladder, the latter not being in contact with the fluid, loses, when exposed to a dry

* How can this be true when the compound, or oxy-hydrogen blowpipe produces a degree of heat, so much superior to that evolved by a stream of oxygen gas directed upon ignited charcoal or metals ?—Ed.

atmosphere, much of its water and becomes stronger. But if the vessel thus closed be exposed to a damp air, the alcohol attracts humidity and becomes weaker.

In a second memoir the author states more particularly the effect of bringing the alcohol into immediate contact with the membrane. If a bladder be filled with 16 ounces of alcohol at 75° and be well closed and suspended over a sand bath, or placed near a warm stove so as to remain at the distance of more than an inch from the hot surface, it becomes in a few days reduced to a fourth of its volume, and is nearly or quite anhydrous.

M. Sæmmering prepares for this purpose calves or beeves bladders, by steeping them first in water, washing, inflating, and cleansing them from grease and other extraneous matters, tying the ureters carefully and then returning them to the water in order to clear off more fully the interior mucocity. After having inflated and dried the bladders M. S. covers them with a solution of Ichthyocolla, one coating internally and two externally. The bladder thus becomes firmer, and the alcholic concentration succeeds better.

It is better not to fill the bladder entirely, but to leave a small space empty. The bladder is not moist to the touch and gives out no odor of alcohol. If the latter be below 16° Baume, the bladder then softens a little and appears moist to the touch.

Bladders prepared as above may be employed more than a hundred times, though they at length acquire a yellowish-brown colour and become a little wrinkled and leathery. The swimming bladder of the salmon is not fit for these experiments. Alcohol of 72° was put into one of them and after an exposure of thirty-two hours, it had lost more than one third of its volume and was weakened 12°. The alcoholic vapour was perceived by the smell.

Into two bladders of equal size was put, into one eight ounces of water and into the other eight ounces of alcohol. They were placed side by side, exposed to a slight heat. In four days the water had entirely disappeared while the alcohol had scarcely lost an ounce of its weight. Mineral waters and that of wells evaporate and deposit on the interior of bladders the saline matters which they contain.

If the heat be conveniently managed, absolute alcohol may be obtained in six to twelve hours. Solar heat is even sufficient to produce anhydrous alcohol.

Wine placed in prepared bladders contracts no bad odour; it assumes a deeper colour, acquires more aroma and a milder taste, and becomes generally stronger. Spirits of turpentine of 75° contained in a cylindrical glass closed with a bladder, lost nothing in four years. Concentrated vinegar lost the half of its volume in four months, the other half acquired more consistency and had no longer an acid taste. The water of orange flowers, was about one third evaporated in a few months, appeared to have a stronger odor and consequently had lost nothing of its volatile principle.—*Ferussac's Bulletin*, *Mai*, 1828.

28. *Beet Sugar in France.*—It appears by a letter addressed to Gay Lussac from M. Crespel Dellisse that there was manufactured in 1827, chiefly in the four northern departments 1,218,000 kilogrammes of sugar from beets, (about 2,750,000 lbs.) and that several new manufactories of the first order were in a course of erection.

Agreeably to the results stated, says the writer, it cannot be doubted that the fabrication of sugar from beets will be advantageously extended in France. It appears that the process of M. Crespel, of crystalizing the syrup slowly in the stoves is the most advantageous ; it gives a greater quantity of sugar and of finer quality ; but it is to be regretted that it requires so long a time and such large stoves. The expence in fuel is also considerable, which must be taken into account in situations where fuel is dear. This new branch of industry is of the greatest interest to France, and it belongs to an enlightened ministry to observe its progress and to favor its operation.—*Ann. de Ch. et de Phys. Jan.* 1828.

29. *Odors affected by electricity.*—When a continued current of electricity passes through an odoriferous body, camphor, for example, its odor becomes weaker and at length entirely disappears. If the body be then withdrawn and placed in connection with the ground, it remains for some time without odor. Camphor resumes its former properties by degrees and very slowly. The author of this curious experiment, William Libri, of Florence, promises to describe it more in detail.—*Idem.*

30. *Employment of Iodine as a Dye.*—It appears from a note by Pelletier that he ascertained during a recent journey

in England, that a large quantity of perioduret of mercury is sold in that country under the name of English vermillion which is employed principally in the preparation of paper hangings. Learning also that Iodine was used in printing calico he analysed a specimen of the coloring material from Glasgow, and succeeded in forming a compound which was a perfect imitation of the English salts. The proportions which he found to succeed best were the following.

Hydriodate of potash - - - -	65
Iodate of potash - - - - -	2
Ioduret of mercury - - - -	33
	100

This salt appeared to have cost in England one hundred francs the kilogramme (2lb. 3 oz.) but could be prepared in France for thirty-six francs, reckoning the Iodine to cost forty francs.

"It appears to me (observes this skilful chemist) that this salt ought to be applied to the stuff before it is passed through metallic solutions. Among the latter, those which give the most beautiful colors are the solutions of lead and mercury. This salt may be applied with advantage to stuffs by the aid of a solution of starch which becomes a beautiful violet, (a known effect of Iodine and starch.) The starch appears also to contribute to fix the salt on the stuffs.

There is another salt also much employed it is said in Glasgow, in calico printing, which I ought also to mention, because it appears not to be much used in France. This is a triple acetate of lime and copper, prepared in the large way by Ramsay, at Glasgow, for the printers. This salt is of a very beautiful blue. It crystalizes in straight prisms with square bases. The summits of the prisms are often replaced by facets, whence result prisms with six or eight planes according to the extension which the secondary faces acquire.

When this salt is decomposed by a fixed alkali, the oxide of copper and lime are precipitated combined, because they meet in the nascent state and in definite proportions. It is certain that the precipitate turns green but little in the air, even in drying, and in its application, it is a kind of *ash blue* which becomes fixed on the stuff. I call the attention of cotton printers to this salt, which may furnish very beautiful dyes, and which cannot become very expensive.—*Bulletin d'encouragement*, *Sept.* 1828.

31. *Packfong.*—This substance, as analysed by M. Brewster, is composed of 31·6 parts of nickel, 25·4 of zinc, 40·4 of copper, and 2·6 of iron. It is employed in China in the fabrication of a great number of utensils such as vases, teapots, goblets, &c. It has the lustre, color and sound of silver.

M. *de Gersdorff*, desiring to introduce into Europe so valuable an alloy, has established at Vienna, a manufactory, in which he prepares this substance in large quantities. His process is as follows :

After breaking the nickel into pieces of the size of a small nut, and dividing the copper and zinc, the three metals are mixed, and put into a crucible, in such a manner that copper may be both at bottom and top ; the whole is covered with pulverized charcoal and the crucible is heated in a wind furnace. It is necessary frequently to stir the mass, in order that the nickel, which is difficult to fuse, may combine with the other metals and the alloy be homogeneous ; it must also be kept a long time in fusion, even at the risk of separating a small portion of the zinc by volatilisation.

The relative proportion of the three metals which compose the packfong, should vary according to the use which is to be made of it. That destined for the fabrication of spoons, forks, &c. ought to contain 0.25 nickel, 0.25 zinc, 0.50 copper. When it is to be used in ornamenting knives, snuffers, &c. it should contain 22 nickel, 23 zinc, and 55 copper. The packfong most suitable for plating, consists of 20 nickel, 20 zinc and 55 copper. For objects which are to be soldered, as candlesticks, spurs, &c. the best alloy is 20 nickel, 20 zinc, 57 copper and 3 lead.

The addition of .020 to .025 of iron or steel, renders packfong much more white, but at the same time more brittle. It is necessary that the iron should be previously melted with the copper.

Packfong cannot be rolled without the greatest precaution. Every time it is passed through the rollers, it must be heated to a cherry red and slowly cooled. When the sheets present any rent, it must be hammered out before it passes again through the rollers.

The goldsmiths apply the pumice stone to packfong, as to silver. Color is given to it, by dipping it in a mixture of 100 parts water and 14 sulphuric acid.

When the turning and filings of packfong are remelted, it is best to add .03 to .04 of zinc to replace that which has been volatilised.

M. Gersdorff sells his packfong at five francs per pound; nickel being sixteen francs.—*Idem.*

32. *Russia: Population and Religion.*—The population of the European states of the Russian Empire, amounts to 51,320,000 souls; thus divided with respect to religion. Greek church, not Catholic, 39,000,000; Catholics of the Greek or Latin ritual, 8,000,000; Protestants, mostly Lutherans, 2,500,000; Mahometans, 1,804,000. The number of ecclesiastics of the various christian sects is 86,440, and their total revenue 32,750,000 francs.

33. *France: Population, &c.*—The population of France, agreeably to the last official census, was 31,845,428 individuals, of whom 30,855,428 were Catholics, 659,000 Calvinists, 280,000 Lutherans, and 51,000 Israelites.

The Catholic clergy amount to 32,576, including dignitaries, curates, officiating ministers, vicars and auxiliary priests, whose maintenance, advanced by the state, amounts, according to the budget of 1827, to 24,655,000 francs.

The two Protestant communions in France have 515 pastors, fed by the state, at an annual expense of 714,000 francs.

The increase of population in the large towns of France, has been incomparably more rapid than in the country. The following table shews the increase in five years in the cities therein named.

Large towns.	1822.	1827.
Paris,	713,966	890,431
Lyons,	131,288	146,675
Marseilles,	109,483	118,943
Bordeaux,	96,944	93,549*
Rouen,	86,735	90,000
Nantes,	68,427	71,739
Lille,	64,291	69,860
Toulouse,	52,328	69,731
Strasbourg,	49,680	49,708

In the department of the Seine (Paris) sur 1000 naissances totales, il y a 326.42 d'enfans naturels. Dans la totalité de la France le nombre d'enfans naturels sur 1000 est 68.07. —*Ferussac's Bulletin, Jan.* 1828.

* Diminution.

34. *Prevention of forgery.*—Messrs. James Atwater and N. & S. S. Jocelyn, of this city, have completed a plan to prevent forgeries and alterations of bank checks, drafts, bills of exchange, post notes, notes of hand, and other similar instruments.

The labor of carrying into effect such a design may be in some measure understood when it is considered, that to the accomplishment of a plan which shall obviate all the difficulties of the present mode of doing business, particularly by means of checks, the several following points should be compassed, viz.

Banks should be protected against losses arising from the depredations of swindlers, effected both by original forgeries and by alterations of genuine checks, and the characters of honest dealers, and tellers of banks, should be preserved from the unjust suspicions which may now sometimes arise from the impossibility of tracing a forgery to its origin. All these exposures exist in the present mode of transacting the business of banks, and the calamitous consequences too frequently arrest the public attention.

That these various objects can be embraced in one plan, within the ordinary limits of instruments of the kinds referred to, and yet admit of that simplicity and facility which the rapid transaction of business requires, is an idea, which, if it ever occurred to any person, was probably regarded only as something to be desired, but scarcely to be hoped for; and consequently, the old and exposed method has continued in use, with all its temptations to the vicious and the unfortunate. It is believed that no attempts have been made hitherto to accomplish more than one of these objects, and that with but doubtful success.

The inventors of the plan now spoken of (which they are securing by patent) claim to themselves the merit of conceiving and executing the whole combination of desiderata, and of removing all the obstacles which necessarily present themselves in an attempt to establish a consistency in the union of so many important points. In the labor and experiments consequent on this undertaking, they have spent more than an entire year; and the result, in the estimation of gentlemen connected with banking institutions, is such as to justify the opinion, that their efforts have been successful, and that the general adoption of this plan will secure the most desirable consequences. It is considered as original; and in the opinion of the most competent judges, it certainly is so in its whole combination and effect, and in nearly all its details.

As regards the liability hitherto existing in all the instruments of the kinds above mentioned, to successful alterations usually effected by the application of chemical agents, they have provided an effectual preventive, so that even signatures and sums may be altered, without its being possible for the swindler to avail himself of his fraud without encountering a moral certainty of detection.

The frequency of frauds, and the prospect that they will continue to increase with the progress of population, business, and the arts, unless effectual efforts are made to oppose every obstacle to their growth, and if possible to remove every hope of success in the attempt, is a sufficient reason for pressing on the attention of the public, and especially of the officers of banks, a plan which promises to accomplish the desired object. We have critically examined the plan above proposed, and have seen it examined by skilful men of business, and by experienced officers of banks; and if there is any mode of evading the effect of this ingenious and important invention, we confess we have not sufficient sagacity to discover it.—*Editor.*

35. *Webster's Dictionary.*—This great work is at length finished. It is comprised in two large quartos; and its appearance does much credit to the publisher and printer.

More time and labor have probably been bestowed on this performance, than upon any other that has appeared in this country. It is the most extensive vocabulary of the language extant: the author states that it contains twelve thousand words words more than Todd's Johnson, and between twenty and thirty thousand definitions more than the most copious English dictionaries before published.

As to the *peculiarities of orthography*, (not numerous however) and the value of the etymology, and the affinities with other languages, ancient and modern, the few who are qualified to judge, will, after due consideration, form an opinion in which the rest of the world must acquiesce. But, as the author justly observes, the principal practical value of the work must consist in a copious vocabulary, and in the comprehensiveness and correctness of the definitions.

It would be too much to expect, that in so great an undertaking there should be no errors; but we feel that we hazard little in saying, that in the two important particulars just named, Webster's Dictionary must, both at home and abroad, stand before all others in the language, and that it will form a valuable part of the treasures of learning common to all countries—not excepting the parent isle—where the English language is studied. We rejoice that the venerable author has survived to witness the actual publication of a work, which has occupied so large a part of his life.

36. *Plaster casts of fossil bones of the mastodon.*—Professor Buckland has recently transmitted to this country, plaster casts of the fossil bones of the mastodon, found in Ava, in the East Indies. Those destined for us, and which through the kind offices of G. W. Featherstonhaugh, Esq. have been received here, are very interesting from their size, and from their being, (as we have the fullest reason to believe,) both in color and form, exact representations of the originals. Among the specimens are huge molar teeth, still retained in the jaws, a large part of whose circuit is preserved. The specimens have been described in the Geological Transactions, 2d series, vol. ii, part 3. They are as follows.

1. A molar tooth of the Mastodon Latidens.
2. The same - - - - lower jaw.
3. The same - - - - upper jaw with part of the palate.
4. The same in lower jaw, anterior part. This portion of the jaw is twenty one inches long, and the tooth contained in it is fifteen inches long on the exterior curve.
5. Mastodon Elephantoides, molar tooth in the lower jaw.
6. The same, upper jaw.
7. The same. One fragment of a jaw is a foot wide.

37. *William Maclure, Esq.*—This gentleman, so well known by his sacrifices and exertions for the cause of science and humanity, recently visited New Haven, and presided on the evening of November 17th, at a meeting of the American Geological Society, held in the cabinet of Yale College, when the plaster casts of Prof. Buckland were exhibited; the officers of the society were elected, and G. W. Featherstonhaugh, Esq. and Mr. Charles U. Shepard were added to the list of members.

Mr. Maclure was on his way to Mexico, where he will pass the winter, as he did the last, in that fine climate, and expects, on his return in the spring, to bring out with him, under the patronage of the Mexican government, a considerable number of aboriginal young men, to be trained in his school of industry, at New Harmony, to a knowledge of useful arts, and the habits that may fit them both to rule and to obey, in a republican government.

38. *Rome.*—A letter to the Editor, from Mr. William C. Woodbridge, dated Florence, June 11, 1828, announces the transmission, for Yale College, by the writer, of the following interesting articles.

1. A model of the tomb of Scipio, in Peperino, a volcanic stone, of which the original tomb is composed, and which is the prevalent rock of Rome.
2. A geological map of Rome and its environs.
3. A book of thirty views of the ruins of Pompeii and Herculaneum.
4. Views of ancient Roman costumes.
5. Views of the Pantheon, Colosseum, &c.

These articles have arrived, and are valuable sources of information and entertainment.

39. *Cleaveland's Mineralogy*, 3d *edition.*—We are requested to say that the new edition is in good forwardness, but has been delayed by the feeble state of the author's eyes. He is however making some progress every day, and the work may be expected as soon as it is possible to bring it to a close.

40. *Schools in the State of New York.*—There are in the State of New York fifty incorporated academies, numerous private schools, and between eight and nine thousand school districts, in which, last year, instruction was regularly given to 441,850 children, besides nine or ten thousand more in the higher seminaries, without includiug the colleges ; so that the whole number of young persons at this moment under instruction in that state probably falls little short of half a million, which is between a fourth and a third of the whole population of the state.—*Public Report*, *Dec.* 1828.

41. Obituary.

The Rev. D. H. Barnes, one of our respected correspondents and coadjutors, was killed almost instantaneously near the close of October, between Nassau and Troy, (N. York,) in consequence of leaping from the stage when the horses were running in full career. He was on his way, by particular request, to attend the examination in the Rensselaer school at Troy. It is well known that Prof. Griscom and Mr. Barnes originated and have conducted, with great reputation and public benefit, the high school of New York, which has sustained a great, but we hope not an irreparable loss, by Mr. Barnes' death. We annex a catalogue of Mr. Barnes' scientific labors, so far as the results are exhibited in this Journal.

1. A Geological Section of the Canaan mountain with a map. Vol. V. p. 8.
2. An elaborate memoir on the genera Unio and Alasmodonta, with numerous figures. Vol. VI. pp. 107. 258.
3. Description of five species of Chiton, with figures. Vol. VII. p. 69.
4. A memoir on Batracian animals and a monograph on the doubtful reptiles. Vol. XI. p. 268. With an additional communication on the latter subject. Vol. XIII. p. 66.
5. Reclamation of Unios. Vol. XIII. p. 358.
6. On Magnetic Polarity. Ibid. p. 70.

His papers were generally presented first to the Lyceum of New York. It is superfluous to speak of the ability by which they are characterized, as this is universally acknowledged.

Mr. Barnes was a man of pure moral and religious habits and principles—a clergyman of the Baptist persuasion. He was a distinguished naturalist in several branches and particularly in conchology—he was an excellent classical scholar and an eminent philologist, especially in his native language, which he was able to illustrate by a comparison with several modern languages—he was eminently successful as a teacher, presided, at different times, over several respectable seminaries, and declined to accept the Presidency of the Columbian College near Washington.*

In relation to the interests of science we record his death with a sensibility which we wish not to separate from a sentiment of sympathy for his family and friends.

"O fallacem hominum spem, fragilemque fortunam, et inanes nostras contentiones! quæ in medio spatio sœpe franguntur et corruunt."

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* Report of the Trustees of the New York High School, Nov. 29, 1828.

George T. Bowen, Professor of Chemistry, &c. in the University of Tennessee.

The death of this promising young man, also a coadjutor, as well as a pupil and friend, is thus announced in a letter from one of his associates: we trust that the personal allusions will be excused by our readers.

"Nashville University, Oct. 29, 1828.

"Prof. Silliman:

"*Dear Sir*—I have to communicate to you the afflicting intelligence of the death of your friend, Mr. Bowen, of our college. He died on the 25th instant, of the hasty consumption, occasioned, as he supposed, by a neglected cold. He was seized with Hæmoptisis or blood-spitting, the first of last July, which continued with intervals, till it settled into a confirmed consumption. He often mentioned your name very affectionately, and requested me on his dying bed to send you an *aerolite* which he had obtained in this country, and with it his best respects, and the hope that he would meet you in a better world. It will be grateful to learn that for three months before his death, he made religion the subject of his undivided attention; bore his illness with great composure and resignation, and died without a struggle, relying for salvation on his Saviour alone.

"I will send you the *aerolite* by the first safe opportunity, and with it a notice of the circumstances attending its fall."

Mr. Bowen early indicated a strong bent towards natural science. While a member of the junior class in Yale College, he obtained special permission from the faculty to occupy, in the chemical laboratory and in the cabinet of mineralogy and geology, under the direction of the professor of that department, all the time which he could save from the exact fulfilment of his college duties.

His pledge to the faculty was faithfully redeemed—their indulgence to an undergraduate was without a precedent, but they had no reason to regret it. In this situation Mr. Bowen spent the leisure hours of two years, discovered uncommon ardor, skill, and perseverance, was a most obliging, devoted and useful assistant, and in a few months, was able to enter upon difficult experiments and to perform regular analyses.

1. His analysis of the sulphat of strontian and the sulphat of Barytes. Vol. IV. p. 324 of this Journal.

2. That of the calcareous oxide of tungsten.

3. That of the pyroxene of New Haven,

4. That of the nephrite of Smithfield, R. I. and

5. The examination of the magnetic effects of the Calorimotor of Dr. Hare, were all performed while he was a pupil in the laboratory of Yale College.*

After leaving that situation, he went through a regular medical education in the University of Pennsylvania; always however, retaining a most decided preference for his favorite pursuits, and his wishes were crowned with complete success by an early and honorable appointment, with, as we have understood from him, an ample endowment of apparatus and other means, and we have no doubt he would have risen to distinguished eminence, if a mysterious Providence had not cut him off at the early age of twenty eight.

Died, at one o'clock in the morning of November 14, Timothy Dwight Eaton, son of Prof. Amos Eaton, and Adjunct Professor in Rensselaer School at Troy; being about 21 years of age. He had devoted to the Natural Sciences most of the few years allotted to him by Providence. He had attended Prof. Silliman's lectures on Chemistry and Mineralogy before he was nine years old, enough to catch that spirit of enthusiasm for the study of Nature, which governed his future life. Under the immediate direction of his father, he had collected, labelled, and preserved, more than one thousand species of plants before he was ten years old. His progress in Mineralogy, Geology, and Zoology, was equally successful. Young as he was, he introduced many improvements in facilitating the manipulations of the Laboratory at the Rensselaer School; where he will long be remembered for his inflexible integrity, industry, and discriminating talents.

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* The four last of these papers, are cantained in Vol. V. of this Journal.

INDEX TO VOL. XV.

A

B

C

D.

E

Bishop Burnet's Lives of Sir Matthew Hale and John Earl of Rochester. In 1 vol. 18mo. with portraits.

Pollock's Course of Time—third edition, with an Index. 1 vol. 12mo.

Dewar's Elements of Moral Philosophy and of Christian Ethics. 2 vols. 8vo.

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