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## ERRATUM.

Page 261, line 20 from bottom, for *variety* read *rarity*.

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Art. I.—*On the Action of Yellow Light in producing the Green Color, and Indigo Light the Movements of Plants;* by D. P. Gardner, M. D., Cor. Memb. Lyc. Nat. Hist. New York.

(1.) The object of this paper is to prove the existence of different properties in the rays of the spectrum, in their action on vegetables; and more especially to show that the rays which produce the green color of plants, are altogether dissimilar from those which influence their movements towards light—the color being developed by the less refrangible rays, and chiefly by the *yellow;* whereas, the motion is influenced by indigo light. The discussion of the subject will be divided under three heads:

1. On the production of chlorophyl by yellow light.
2. On the movements of plants towards indigo light.
3. Some application of these facts to vegetable physiology.

I. *On the production of chlorophyl by yellow light.*

(2.) It is a fundamental fact in botany that light is necessary to the formation of chlorophyl. Von Humboldt adduced certain exceptions to this law, in the case of plants found in the mines of Freyberg, and with Senebier ascribed the green matter to the action of hydrogen gas. But the experiments of the latter failed in the hands of De Candolle, and a series instituted by myself, and conducted with great care, were equally unsuccessful. On the other hand, Humboldt succeeded in greening a plant of *Le-*

*pidium sativum*, raised in darkness, by the light of two lamps, and De Candolle obtained the same result with six Argand lamps.

(3.) The investigation has been subsequently confined to the name of the ray which produces chlorophyl.* Formerly it was tacitly admitted on the authority of Senebier that the *chemical* or blue ray was most active. Prof. Morren (Annal. des Scien. Nat., Oct. 1832) ascribed it to the luminous colors, more especially the rays which had passed through bright yellow and orange glasses. Dr. Daubeny (Phil. Trans. 1836) in his valuable researches arrived at the same conclusion. The next investigator, Dr. Draper, (Jour. Franklin Inst. 1837,) obtained better results in yellow than blue light. Mr. Hunt in 1840 (Lond. and Edinb. Phil. Mag. April) resumed the question, and published the most decided results (p. 272) to the effect, that *blue light alone* causes the green color of plants, and that the yellow and red rays, "*destroy the vital principle in the seed.*" In 1841, he was one of a committee appointed by the British Association to report on this subject, and in a subsequent conversation at the late meeting of that body, has repeated his statements. Being the last writer, his results have given a prominence to the doctrine that chlorophyl is produced by the blue rays, so as to mislead Prof. Johnston in his agricultural lectures, and Prof. Graham. (Chemistry, p. 1013.)

(4.) In September, 1840, I repeated Mr. Hunt's experiments in Virginia, and obtained dissimilar results. A known number of turnip seeds were sown, and every grain germinated in the yellow and red rays. The greenest plants were found in yellow light. Every condition was favorable, and the results well characterized, but my reason for deferring the publication arose from a conviction that the use of solutions and colored glasses was objectionable—and *that no perfect results could be obtained except with the spectrum.* Plants exposed to light which has permeated cobalt glass, are not placed in blue rays, but in red, yellow, green, blue, indigo, and violet, in proportions differing with the tone of color, and thickness of the material. The effect may

* *Chlorophyl*—the green matter of leaves. It is insoluble in water, but soluble in ether and alcohol. The ultimate analysis has not been made; but chemists agree that it is of the nature of wax. The yellow color of autumnal foliage is due to a similar yellow wax, called *Xanthophyl*, supposed to be produced by the action of frost on the former substance.

therefore be produced by any of these rays, or by their peculiar combination. (See Sir J. F. W. Herschel's paper in the Philosophical Transactions for 1840, p. 24, on "the combined action of rays of different degrees of refrangibility.")

(5.) I shall not attempt to explain the discrepancy between my results and those of Mr. Hunt, for I do not esteem researches, such as all the foregoing, made with colored media, of any value in this branch of vegetable physiology. It is well to remark, however, that in treating of the germination of cress-seed behind the blue, green, yellow, and red media, he states "that the earth continued *damp* under the *green* and *blue* fluids, whereas it *rapidly dried* under the *yellow* and *red*." (p. 271.) This difference would by most persons have been considered sufficient to retard or "destroy"? germination.

(6.) Other engagements in 1842 interfered with my design of examining this question with the spectrum, and it was not until July, 1843, that such arrangements were made as are necessary to the prosecution of the subject.

(7.) *The apparatus.*—A beam of the sun's light was directed by a heliostat placed outside my window, along a square tube of wood, passing through the shutter. The inner extremity of the tube was closed, and contained near its end a flint glass equilateral prism, one inch on the side and six inches long, with the axis adjusted perpendicularly. The dispersed light passed into the chamber, through an aperture in the side of the tube. All that portion of the beam, which exceeded the breadth of the prism, was cut off by a diaphragm. The object of these arrangements was to render the room dark. The experiments were performed in Virginia, in latitude 37° 10′ N., and continued from July 6th to October 1st, during a season of unusual brilliancy and temperature.

(8.) *Arrangements for the experiments.*—Seedlings of turnips, radish, mustard, peas, several varieties of beans, peas, and the following transplanted specimens, were used—*Solanum nigrum*, *S. Virginianum*; *Plantago major*, *P. minor*; *Polygonum hydropiper*; *Chenopodium rubrum*; *Rumex obtusifolius*. They were placed in boxes with partitions, or planted in jars and grew in darkness until ready for experiment, so that they acquired a yellow color. The number of plants exposed to each ray averaged one hundred, when the smaller seeds were used, and the result indicated was obtained by a comparison of the whole. The age of seedlings is a matter of moment; those which are young, and from one inch to one inch and three fourths high, in the case of turnips, were most sensitive; indeed, these plants were found to give the best results, and were used almost exclusively after the first month.

The spectrum was allowed to fall on the specimens at a distance of fifteen feet from the prism, and undecomposed light shut out by screens. Each ray acted in a separate compartment, unless otherwise stated.

(9.) The following extract of an experiment, will show some farther details.

*August* 13*th.*—Five jars, containing each about one hundred turnip seedlings, were placed respectively in the orange, yellow, blue, indigo, and violet rays at 9h. A. M. *Day*, bright—temperature in shade at noon 80° Fah., in the sun 95°. Duration of sunshine 6½ hours. Result at 3½h. P. M. The third column of the table shows the altitude of the plants at the commencement of the observation.

| Jar. | Light. | Height at 9h. | Result. | Order. |
|---|---|---|---|---|
| 1 | orange | 1 inch | green | 2 |
| 2 | yellow | 1 " | full green | 1 |
| 3 | blue | 1¼ " | slight olive | * |
| 4 | indigo | 1 " | yellow | 0 |
| 5 | violet | 1¼ " | yellow | 0 |

*August* 14*th.*—The same plants with the addition of a fresh crop (6) in the green ray. Exposure from 9h. A. M. to 3h. P. M. or six hours sunshine. Temperature in shade at noon 85° Fahr., and 105° in the sun. Result at 3h. P. M.

| Jar. | Light. | Height at 9h. | Result. | Order. |
|---|---|---|---|---|
| 1 | orange | 2¼ inches | full green | 2 |
| 2 | yellow | 2¼ " | perfect green | 1 |
| 3 | blue | 3 " | slight green | 4 |
| 4 | indigo | 3 " | yellow | 0 |
| 5 | violet | 3½ " | yellow | 0 |
| 6 | green | 1 inch | fair green | 3 |

* The fifth column contains a comparative estimate of the depth of color, assuming unity at the highest value; on this scale the plant in blue light did not become green, and the value is negative, but there was a visible alteration designated olive, and indicating the tint which vegetables assume in passing from the yellow color of darkness to green.

The leaves of 1 and 2 were developed. *Experiment* concluded after 30 hours, of which 12½ were sunshine, and 17½ darkness. The greater altitude of the plants in the indigo and violet rays—a fact discovered by Morren, is due probably to the slowness of exhalation by vegetables in those colors, an effect not of light, but of heat. In this observation, no result whatsoever was produced on the original yellow color of the seedlings in the indigo and violet rays.

(10.) The ensuing table contains the comparable points of six similar experiments. The 1st column gives the number of the observation; the 2d, the plants used; the 3d, the number of hours of sunshine; the 4th, the whole duration of the experiment; and from the 5th to the 13th column, the rays of the spectrum; the figures in the last spaces indicate only the order of color in the particular observation. The sign of minus is introduced, whenever the effect of the ray was not tested, or the result was defective.

TABLE, *showing the* ACTIVE *and* INACTIVE *rays of the spectrum, in producing the green color of plants.*

| Experiment. | Plants. | Hours of light. | Total time. | ACTIVE RAYS. | | | | | INACTIVE RAYS. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Red. | Orange. | Yellow. | Green. | | Blue. | Indigo. | Violet. | Lav'nder. |
| 1 | turnips | 22 | 109 | 4 | 2 | 1 | 3 | — | 0 | 0 | 0 | 0 |
| 2 | beans, &c. | 14 | 95 | – | 2 | 1 | 3 | — | 0 | – | – | – |
| 3 | turnips, &c. | 8 | 69 | 4 | 2 | 1 | 3 | — | – | – | – | – |
| 4 | turnips | 23 | 101 | – | – | – | 1 | — | 0 | 0 | 0 | 0 |
| 5 | turnips | 17.5 | 52 | – | 2 | 1 | 3 | — | 4 | 0 | 0 | 0 |
| 6 | turnips | 5.5 | 6 | 4 | 2 | 1 | 3 | — | 0 | 0 | 0 | 0 |

In experiment 5, the blue ray produced a green color, but the usual effect was a light olive. The indigo, violet, and lavender portions were always inactive, although several observations were continued until the plants faded.

(11.) Under favorable circumstances it requires a long exposure to develope chlorophyl. The shortest period I witnessed was in a crop of turnip seedlings, which required two hours in the centre of the yellow rays, but frequently six or more hours were necessary. In the full sunshine of Virginia, it requires more than one hour to produce the same effect.

The color acquired is not fugitive. It has been observed, scarcely changed after seventy two hours' darkness, in turnips, and seven days in beans. Plants from the field preserve their color sometimes for weeks, but finally become yellow.

(12.) The fact established by these experiments is, that the less refrangible rays are most active in producing the green color of plants. It is not stated, that the blue, &c. rays will not effect this change *in time*, but, that they are remarkably inactive.

(13.) *The maximum action is in yellow light.* For the purpose of obtaining a measure of the comparative activity of each ray, the following experiment was made. The spectrum of a circular beam of light three fourths of an inch in diameter, was received upon a double convex lens of three feet focus, placed near the prism. The dispersed rays passed through a chink of one fourth of an inch into a camera, and each fell into a separate compartment, containing a few turnip seedlings, situated near the focus of the ray. The place of the extreme red and central yellow rays was determined through cobalt glass, and the whole spectrum divided into the spaces given by Fraunhofer, for the width of each color. The arrangements being carefully adjusted, the plants were examined at intervals, by allowing a little diffused light to fall upon them, and excluding the spectrum; in this way, the number of hours was obtained in which a given ray produced a certain effect. The depth of green color was estimated, by carefully comparing the plants, with a selected specimen; in this I was assisted by a friend, whose eye is well skilled in distinguishing between shades of color.

(14.) The best result gave for the yellow 3½ hours, the orange 4½ hours, and the green ray 6 hours; the plants were selected from the centre of each group, and all the measures obtained on the same day during uninterrupted sunshine. The experiment was continued until 17½ hours of sunlight had acted upon the seedlings in the blue space, which then acquired a tint estimated at one half that of the test. In another observation the indigo, violet, and lavender of Sir John Herschel produced no effect in 23 hours.

(15.) From these experiments I conclude that the *centre of the yellow ray is the point of maximum effect in the production of chlorophyl;* and that the action diminishes on either side to the termination of the *mean red* and *blue.*

(16.) In this stage of the subject, an interesting question suggests itself—is the active agent LIGHT? some form of chemical ray? or heat?

To discover whether it was due to Tithonicity,* I placed a crop of turnip seedlings in a box, illuminated exclusively with light, which had traversed a solution of bichromate of potassa, sufficiently concentrated to absorb all tithonic rays. The plants became green in about 2½ hours, so as to indicate not only, that detithonized light was capable of producing the green matter, but of doing so with remarkable activity. *Hence, the formation of chlorophyl is not due to Tithonicity.*

Nor is heat the active principle, for the maxima of heat which has traversed flint glass, do not correspond with the rays which produce the chief action on etiolated plants. *Chlorophyl is therefore produced by the imponderable* LIGHT, *as distinguished from all other known agents found in the sunbeam.*

## II. *On the movements of plants towards indigo light.*

(17.) Among the most interesting phenomena of plants, is the apparent instinct of bending towards light. The character of the movement may be seen with ease, by exposing a crop of turnip seedlings near the light of an Argand lamp, provided with an opaque shade. If they be adjusted in such a manner as to leave the leaflets slightly above the lower margin of the shade, the whole will be found inclined forwards in two to four hours. It is this movement I propose to examine.

(18.) All erect plants obtained in darkness, when exposed to the solar spectrum, in distinct compartments, incline themselves forwards towards the prism. It is therefore an effect which is produced in every variety of light—even obscure light can accomplish it; therefore, in researches on this subject, every precaution must be taken to darken the place of experiment. The amount of bending frequently exceeds ninety degrees, and a movement of the free extremity of the stem through one inch to one inch and a half from the perpendicular, is not unusual in turnip seedlings.

(19.) If the young plants be exposed to a spectrum produced as in Art. 13, in a box without compartments, after a time they

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* See Dr. Draper's paper in the Lond. Edinb. and Dub. Phil. Mag. for Dec. 1842. *Tithonicity* is the name of an imponderable agent, supposed to differ from light, by being invisible; and from heat, by not being conducted by metals and incapable of producing the expansion of bodies. From this term *tithonometer* and *tithonic* rays are derived.

will be found inclined diagonally towards a common axis—those in the red, orange, yellow, and green, bending towards the indigo, and the plants of the violet and lavender spaces moving to meet them. When a larger spectrum of fourteen inches was used, and the seedlings exposed for five hours, they were so inclined as to suggest the appearance of a field of growing wheat blown by two winds to a common point. If the experiment were sufficiently prolonged, some of the plants from either side of the spectrum interlocked in the direction of the axis.

(20.) *This axis is in the direction taken by Fraunhofer's indigo ray in passing from the prism to the plants.* The seedlings growing in indigo light inclined directly along it; but those of the red and orange did not move towards the radiant in the prism, but along a diagonal, inclined in part towards the plants illuminated by the active rays, which were much nearer than the prism. The amount of this lateral inclination diminished as the plants were nearer the axis, so that those illuminated by blue, violet, and lavender, were little deflected from a line drawn from their place of growth to the radiant. Seedlings in the red, orange, and yellow rays, frequently bent to such an extent, as to cause their summits to pass through the adjoining colored space.

(21.) The secondary (lateral) inclination did not occur when the radiant was a reflected image of the spectrum, which was not allowed to fall on any of the plants. If the mirror reflected neither of the more refrangible rays, the plants appeared to be inclined to the light immediately before them.

(22.) These experiments satisfied me that the active force was in the indigo ray, and the intensity of the light necessary to produce deflection was extremely feeble, so that an amount inappreciable to the eye, which is an admirable measure of the intensity, but incapable of estimating the effect of quantities, would after a lengthened exposure, cause considerable deflection. Indeed the phenomenon is so little dependent on the brilliancy of light, that very little seems to be gained by concentrating the rays beyond a certain point. There is sufficient activity in each prismatic color to produce bending, if enough time be allowed. The movement is therefore a result depending upon the absorption of light.

(23.) As this is an entirely new subject, it is thought expedient to advance some further evidence concerning the position of the deflecting force. For this purpose, the spectrum was allowed to fall upon a screen, perforated by two similar apertures, in such positions as to allow the red ray to pass through one, and the indigo through the other. Behind the screen, a box was placed containing four jars of turnip seedlings, arranged along a line occupying the centre between the intromitted rays. The light passed through the box without any reflexion, and was stifled by black cloth when it reached the further extremity. All the plants commenced bending in a short time, and in two hours the nearest group were inclined forwards 90°, and laterally 50° towards the indigo aperture, the edges of which formed the radiant. In three hours, the second crop exhibited the same movement, and so with the plants of the third and fourth jar. At the conclusion of the experiment in six hours and a half, all were bent forward at about 90°, and each group inclined towards the indigo aperture, in a direction indicated by drawing a straight line from the plants to the radiant. Not one plant inclined towards the red ray, although half the collection were at first nearer to it, than to the more refrangible light.

With similar arrangements the yellow, orange and green rays were contrasted with the indigo; and always with the foregoing result. The time necessary to develope a satisfactory lateral inclination from the green rays, is greater than in the experiments made between the less refrangible rays, and indigo.

(24.) The same results were obtained when the radiants were reflected images. The extent to which the influence of the active light is felt was frequently surprising; in some of the observations pea plants were situated four feet from the indigo, and within half an inch of the yellow, red or orange radiant, notwithstanding which, they inclined towards the indigo. In these researches, the mirror was so situated as to reflect no prismatic light upon the plants.

(25.) That no doubt may rest, on the place of the soliciting force, another arrangement was used. The instrument figured by M. Pouillet, (Elemens de Phys., &c. t. 1, fig. 218,) for examining the effect of combinations of rays of light in producing color, was taken. Red rays were received on one mirror, and indigo on another, and the two so far inclined as to cause the rays to intermix at a place about three inches in advance of the instrument, and out of the incident beam. A jar of turnip seedlings was then placed so as to receive the compound light in its centre—the plants being illuminated in part by the red, indigo and purple rays. In two hours the movements were considerable, and somewhat complex. Every plant lighted by the indigo rays, was inclined directly to that radiant. Those which received red light, were bent to the central purple, and none to the red radiant. But many seedlings at first in the red, inclined themselves towards the purple, and after being fully illuminated thereby, commenced a lateral movement towards the indigo radiant, so that, at the close of the experiment, their stems exhibited two inclinations, one in a vertical, and the other in a horizontal plane.

(26.) Plants raised in darkness, as well as those which were green, were used in the preceding observations—but the sensibility of the former greatly exceeds that of the latter. Indeed, plants that have been exposed to light for several days, become sluggish in their movements, and the phenomenon probably ceases in parts which are ligneous. In the seedlings submitted to examination, the movements were found to take place, in consequence of an action impressed upon the stem only, for the removal of the leaflets did not alter the result. A still more remarkable fact was discovered in all the cases observed—that after complete bending, plants erect themselves again, when placed in darkness, at least in situations so dark, as to appear entirely deprived of light. This effect is best seen in seedlings which have never been exposed to the direct rays of the sun; for, after full and lengthened exposure, it diminishes almost to zero. The action of light in producing movement, seems therefore to be transient, that is, it is not accompanied with a permanent change of structure in the stem.

(27.) From all the foregoing experiments, it is demonstrable—*that the force, which constrains the movements of plants towards light, has its maximum in the indigo ray.*

(28.) But the solar beam contains a number of agents, one of which more especially developes itself in this part of the flint-glass spectrum, acting upon argentine compounds with great effect. Dr. Draper has discovered the existence of chemical action, distinct from the rays of light, or heat, throughout the spectrum, and terms the agent which produces it Tithonicity. Is the bending of plants produced by the *tithonic rays?* by *heat?* or by LIGHT?

(29.) The investigation of these important problems has cost me much labor, but the following results will show, that a satisfactory solution has been attained.

A trough of plate-glass, containing persulphocyanide of iron, which has the property of absorbing the tithonic rays of the indigo space, and allowing indigo light to pass, was placed before a small aperture, made in the side of a suitable box. The proper place for the hole, was determined by receiving the analyzed spectrum on a Daguerre plate, resting against the box. In a few minutes, two stains were observed, with an interval between them, corresponding to the place of the indigo light. The inactive space was marked on the wood, and a perforation made in its centre, without deranging the adjustment, so that the aperture continued to admit detithonized light. Plants placed in this box were bent in two hours, whilst a crop illuminated by indigo rays, which had not been transmitted through the solution, did not move with much more activity, although one crop was exposed to the maximum of the indigo tithonic rays, and the other placed in detithonized light.

(30.) Solution of bichromate of potash, intercepts nearly all tithonic matter, but permits the free passage of luminous rays. A crop of turnip seedlings was introduced into a box and illuminated by the yellow rays of the spectrum, analyzed by this solution. A Daguerre plate was also introduced, to serve as a test of chemical action. In two hours and a half the plants were all equally bent, and the plate but slightly stained on one edge. A group of similar plants exposed in the same place, without the solution, were inclined in a period of time not materially different. If the bending had been due to tithonicity, the seedlings should have moved towards the place where the silver was stained.

(31.) The tithonic activity of rays transmitted through the above solution, from an Argand lamp, is diminished to less than one two-hundreth part, as measured by Dr. Draper's tithonometer.* But plants were bent in light from this source which had traversed the solution, in a period of time not much greater than that required in the full blaze of the lamp.

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* *Tithonometer*—an instrument for measuring the chemical force of rays, by the union of chlorine and hydrogen.

This result alone, is abundantly sufficient to decide the question, and show the total inactivity of the tithonic rays in producing these vegetable movements.

(32.) That the bending is not due to heat, appears from the following considerations. The action is greatest in those parts of the spectrum which give evidence of least heat. The axis is approached on one side by plants from the red, orange, yellow and green, and by those from the violet and lavender on the other, which is a phenomenon, altogether inexplicable on the supposition, that heat is the active agent.

Plants shut from the light of an Argand lamp, by a plate of copper foil, do not incline to the warm metal.

Finally, the moonbeams, even without condensation, are capable of producing extensive bending, in one or two hours. This result is conclusive of the question, for no trace of caloric can be found in the moon's light.

(33.) As far, therefore, as the presence of heat can be determined by thermoscopes, or the tithonic rays, by argentine compounds, and the union of chlorine and hydrogen, we are justified in concluding that the movements of plants are effected by a totally different agent. LIGHT *only, remains in the spectrum, so far as we know, and to it, therefore, I refer the motions under consideration.*

(34.) This conclusion is of deep interest, inasmuch as *it is the first case of a movement, perceptible to the eye, being traced to the unaided action of light.* That this imponderable produced molecular changes was readily admitted, but its influence in bringing about palpable movements of considerable extent, has never been suspected. In the irritability of the *iris*, physiologists have always seen the influence of nervous matter; but in plants no such agent exists to complicate the phenomenon, and therefore the action is due to light only.

In this newly discovered property, light is also more closely assimilated to the other imponderables—for both heat and electricity are capable of producing palpable motion.

III. *Some applications of the preceding facts, &c.*

(35.) Numerous applications to vegetable physiology will suggest themselves to the reader, but it is my purpose to treat only of the following.

*The intimate relation which exists between the rays which produce chlorophyl, the decomposition of carbonic acid, and the luminous spectrum.* The maximum for the formation of green matter, has been shown to reside in the yellow ray. Dr. Draper (Lond. and Edinb. Phil. Mag., Sept. 1843) discovered the maximum action, for the decomposition of carbonic acid, to be between the green and yellow, or more correctly, in the centre of the yellow. Sir W. Herschel and Fraunhofer placed the maximum for light in the same space.

(36.) The relation goes further; for if the quantities obtained by Dr. Draper for decomposing action, as measured by liberated gas—Fraunhofer for illuminating power, determined by the eye —and my estimate, obtained in time and by the eye—be rendered commensurable and tabulated, they will give quantities nearly allied. To produce such a table, I assume all the maxima equal to unity. My results being in *time*, and theirs in *effect*, the inverse proportion is taken for each value given in Art. 14.

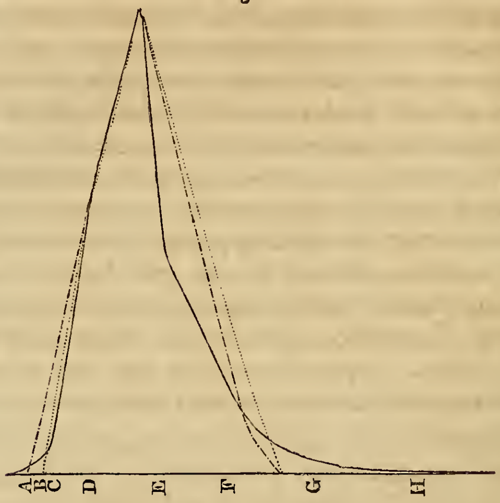
TABLE *showing the force of the solar rays, in producing the green color of plants, the decomposition of carbonic acid, and illumination.*

| Places examined. | Production of chlorophyl. | Decompos. of carbonic acid. | Illuminating power. |
|---|---|---|---|
| Extreme red, . . . . . . | 0.000 | 0.0000 | 0.0000 |
| Line B, . . . . . . . | . . | .0091 | .0320 |
| Line C, . . . . . . . . . | . . | . . | .0940 |
| Commencement of orange, | . . | .5550 | |
| Line D, . . . . . . . . . | . . | . . | .6400 |
| Centre of orange, . . . | .777 | | |
| Centre of yellow, . . . . . | 1.000 | 1.0000 | 1.0000 |
| Line E, . . . . . . . | . . | . . | .4800 |
| Centre of green, . . . . | .583 | | |
| Line F, . . . . . . . | . . | . . | .1700 |
| Centre of blue, . . . . | .100 | | |
| End of blue, . . . . . | . . | .0027 | |
| Line G, . . . . . . . . . | 0.000 | 0.0000 | .0310 |
| Line H, . . . . . . | 0.000 | 0.0000 | .0056 |

Upon projecting these numbers, which although not rigorously correct are very good approximations, the unity of the active agent will be more strikingly exhibited. Let the axis of abscissas be divided into intervals corresponding to Fraunhofer's colored spaces, and the positions of the mean places of the dark lines be marked from Mr. Powell's recent work on dispersion.

The ordinates are from the table. Fraunhofer's estimates are indicated by a bold line, Dr. Draper's by dots, and my own by an interrupted line, fig. 1.

Fig. 1.



Had more points in these figures been determined, there is no doubt they would have coincided precisely. It is not to be forgotten, that these results were obtained in places many hundred miles apart. They determine, what hitherto has only been conjectured, that the greening of plants, and decomposition of carbonic acid, are produced by the same agent—which is also the active imponderable in producing vision—a phenomenon in no way similar, as suggested by M. Möser, to the change of Daguerre's plate, which is a tithonic action. The dependence of the depth of green color in foliage, upon brilliant light, is also shown. The statements of travellers, in respect to tropical vegetation, confirms this conclusion.

(38.) Chlorophyl, the body generated in the yellow leaflets of plants, raised in darkness, by the action of light, is a hydrocarbon, of the nature of wax. Whether it be produced by decomposition of carbonic acid, or be the yellow matter, or some other substance, as dextrine, already present in the leaf, which has suffered deoxidation, is altogether unknown. The latter view, applied to the formation of oils, and fats in animals, by Liebig, is probably correct—by adopting it, we are relieved from all difficulty in regard to the supply of hydrogen, in plants; for the evidence, that water is decomposed in their structures, is by no means conclusive. In the formation of oils in seeds, it is known that the deoxidation of sugar occurs; for we have the liberation of carbonic acid from the petals, &c. and a destruction of the organic matter.

Subsequently to the production of chlorophyl, carbonic acid is decomposed by light, and this function, directly or indirectly, is sufficient to generate all organic matter. Hence the existence of all organic matter is due to the LIGHT of the sun.

(39.) *On the destruction of chlorophyl by light.*—The production of green matter, by the yellow rays, leads us to infer its destruction by the blue and red. Sir J. F. W. Herschel (Phil. Mag. Feb. 1843) found that the expressed juices of leaves are acted upon by the spectrum, with much uniformity. In the case of elder leaves, (fig. 8,) there was a strong maximum, producing a nearly insulated solar image at −11.5, of his scale,* or nearly at the end of the red rays—the action thence was feeble, with two minima at −5.0 and +6.8, with a slight intermediate maximum at (0.0) the centre of the yellow, and beyond these, or about the termination of the green, the action again increases, reaches another maximum at +20.0, which corresponds to the centre of Fraunhofer's indigo, after which it declines to a point beyond the violet +45.0.

I have been thus precise in giving his result, because my experiments made with ethereal solution of chlorophyl from grass leaves spread upon paper, gave similar spectra. There are two points, however, which it is necessary to discuss.

The first action of light is perceived in the mean red ray, and it attains a maximum incomparably greater at that point than elsewhere—the next place affected is in the indigo, and accom-

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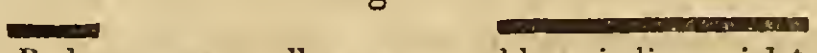
* By proceeding as in Art. 13, a spectrum is obtained which has only the width of the focal picture of the sun, and is of considerable length; these elements differ, however, with the focal distance of the lens. Upon examining such a spectrum through cobalt glass, a perfectly circular image of the sun is seen at the extreme red end, another in the centre of the yellow, and the termination of the violet is sharp and distinct. Sir John Herschel takes the centre of the yellow thus insulated as his zero point, and using a scale of thirtieths of an inch divides the distance between it and the red end into negative parts, and in the direction of the violet positively. The spectrum he used contained 13.30 negative, and 40.62 positive parts, and was therefore $\frac{53.92}{30}$ inches long. My spectrum corresponded with this very closely.

panying it, there is an action from +10.5 to +36.0 of the same scale, beginning abruptly in Fraunhofer's blue. So striking is this whole result, that some of the earlier spectra obtained by me, contained a perfectly neutral space from −5.0 to +10.5, in which the chlorophyl was in no way changed, whilst the solar picture in the red was sharp and of a dazzling whiteness, and the maximum of the indigo was also bleached—producing a linear spectrum, as in fig. 2, in which the orange, yellow and green rays are inactive; these it will be remembered are energetic in forming the green matter.

Fig. 2.



Red, orange, yellow, green, blue, indigo, violet.

Upon longer exposure, the subordinate action along the yellow, &c. occurs, but not until the other portions are perfectly bleached.

In Sir J. Herschel's experiments there remained a salmon color, after the discharge of the green. This is not seen when chlorophyl is used, and is due to a coloring matter, insoluble in ether.

(40.) No ground exists therefore for the theory that the autumnal tint of leaves is due to the residual, after the destruction of the green color. Xanthophyl, which imparts the yellow, depends on an organic change of chlorophyl, which Berzelius could not imitate. (Journ. de Pharm. Juillet, 1837.)

Some observations made with a view of determining the action of indigo light on the green of living plants, brought me to the conclusion, that it faded into a yellowish green color—but I will not speak positively. Plants do, however, lose all their greenness in a dark place, after a greater or less time, and become of the color of seedlings raised without light. In this result my experience is at variance with the statement of Macaire Princep, "Les feuilles d'une plante conservées à l'abri de la lumière s'en detachent colorées vert." (In Berzelius, Chimie, t. 6, p. 42; from Mem. de la Soc. Hist. Nat. de Geneve, t. 4.)

(41.) In the *bleaching of chlorophyl,* as well as in its production, *the active agent is* LIGHT, for it will take place behind a medium excluding the tithonic rays, and the points of activity have no relation to the maxima of the calorific spectrum. See Sir John Herschel's paper, (Phil. Trans. 1840, Part I, p. 51,) "on the distribution of the calorific rays of the solar spectrum."

(42.) The coincidence shown to exist between the illuminating power, activity of decomposition, and greening effect of yellow light, is conclusive of the discussion respecting the rays which are favorable to the growth of vegetables. Blue light cannot be the best, as originally affirmed by Senebier, and subsequently maintained by Mr. Hunt—nor would a conservatory glazed with cobalt glass answer the expectations of Professor Johnston.

(43.) It is impossible to conclude, without calling the attention of physiologists to the remarkable fact, proved in the second part of this paper—that *indigo light* possesses a soliciting power, capable of governing the direction of the stems, peduncles, &c. of plants; an action accomplished by light incomparably feeble in comparison with the yellow rays. The blue of the atmosphere is scarcely less intense, when compared with the sun's beams. *Does not the color of the sky, therefore, regulate the upright growth of stems to a certain extent? Is it not in virtue of the soliciting force therein, that plants continue to grow erect, whenever other disturbing forces are in equilibrio?* These questions might be investigated with profit, were not this communication too extended already.

(44.) It is proper to state, however, that De Candolle's theory of the bending of plants towards light, has been fully disproved in the context,* in as much as it is effected by the indigo rays which have not power to decompose carbonic acid and produce lignin, &c. (See *Mem. Soc. d'Arcueil*, 1809, *p.* 104.)

In conclusion, it appears that the following facts have been established.

1st. That chlorophyl is produced by the more luminous rays, the maximum being in the yellow.

2d. This formation is due to pure LIGHT, an imponderable distinct from all others.

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* De Candolle advanced a theory to account for the bending of plants towards light, on the following grounds. That as the side of any plant nearest the light was acted on thereby, whilst the distant portions were unilluminated, carbonic acid would be decomposed, and lignin, &c. produced on one side, and not the other. The plant becoming firmer on the part thus furnished with woody fibre, bent over towards the luminous source.

3d. That the ray towards which plants bend occupies the indigo space of Fraunhofer.

4th. This movement is due to pure LIGHT as distinguished from *heat* and *tithonicity*.

5th. *That pure* LIGHT *is capable of producing changes which result in the development of palpable motion.*

6th. The bleaching of chlorophyl is most active in those parts of the spectrum which possess no influence in its production, and are complimentary to the yellow rays.

7th. This action is also due to pure LIGHT.

We have, therefore, an analysis of the action of every ray in the luminous spectrum upon vegetation. The several effects produced are not abruptly terminated within the limits of any of the spaces, but overlap to a certain extent, a fact which coincides with our experience of the properties of the rays. Whilst *heat* and *tithonicity* are capable of causing the union of mineral particles, *light* appears to be the only radiant body which rules preeminent in the organic world. To the animating beams of the sun we owe whatever products are necessary to our very existence.

New York, Oct. 18th, 1843.

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ART. II.—*Remarks on Zoological Nomenclature;* by S. S. HALDEMAN, Professor of Zoology in the Franklin Institute, Philadelphia.

IT is gratifying to perceive with what unanimity certain rules, tending towards an uniformity of practice on this subject, have been adopted, by naturalists of different countries. The basis of these is undoubtedly the *practice* of Linnæus; but Smith, Willdenow, Swainson, (Cab. Cyc. *Birds*, p. 231,) Illiger, and Rafinesque, by special rules; and other naturalists by custom, have enlarged the original code as additions became necessary.* The laws laid down by the British Association, being founded upon modern practice, contain little that can be objected to; and

* The Academy of Natural Sciences of Philadelphia has decided that the author to whom a species originally belongs, is entitled to the citation of it, in whatever genus it may be subsequently placed by others; and that the reading of a paper before a society, does not constitute a publication.

the committee that framed them were evidently conscious that they were laboring, not for their countrymen alone, but for the scientific world at large; and those laws are undoubtedly the best, whose authority will be admitted by the greatest number of authors interested.

This Dr. Gould (Vol. xlv, p. 10 of this Journal) appears to have overlooked, in his excellent remarks on the subject, or he would probably not have demurred to the requisition that specific names should have a small initial letter. The committee (general convenience out of the question) evidently saw the impropriety of imposing the partial practice of their own vernacular upon a language used to a great extent in other lands, where no local practice would be admitted. We know it to be customary in Germany and France, to commence all adjectives with a small letter; whilst in English, many words derived from persons and places follow the same rule.*

If no distinction be made in favor of personal names (universal consent being, in this instance, more important than classical precedent,) it will have a tendency to discredit the practice of commemorating every collector with a species. Nor do I think so lightly of the objection that isolated generic and specific names may be confounded. Mythological names are used in both ways to a great extent, many generic names are pure adjectives, and many specific ones have been raised to generic, so that the distinction indicated by the initial letter, becomes of great service. The following are a few of those used both in a generic and specific sense:—*rupicola*, *spectrum*, *aotus*, *microstoma*, *chromis*, *cynocephalus*, *molossus*, *glaucus*, *gobio*, *calceola*, *crabro*, *trochilus*.

The practice was introduced here twenty-five years ago, of writing personal specific names without a declensional termination, and a few authors appear disposed to revive it. Thus we have *Squalus cuvier*, Les., *S. spallanzani*, *Squatina dumeril*, and perhaps *Chama lazarus*. This, with the genitive *merilii*, the adjective *merilina*, *spallanzanæus*, gives us three forms for a personal specific appellation,† and I see no particular objection

* As galvanic, galvanism, calvinism, delphic, transatlantic, congreve-rocket.

† As in English, we can say, the Washington monument, Washington's monument, or the monument of Washington.

to either. The first form is not objectionable, as our modern names are properly indeclinable, and the addition of a Latin syllable does not convert them into Latin words.

Whether generic and specific names should be inflected or not, must be left to future practice. An opinion appears to obtain that they may be considered indeclinable, as we seldom see them employed, except in their usual form; so seldom, indeed, that we are quite strangers to the plurals used by the older authors, as Gilbert White's *Hirundines rusticæ*, *Hirundines apodes*, or *Motacillæ trochili.* Many generic names are difficult to decline; the rapidity of composition does not allow time for examination, and some respectable naturalists have not had a classical education; besides, many names are not in the dictionaries, and have no corresponding rule in the grammars.* Some authors would much rather reconstruct sentences, than attempt to inflect words of the following character: Alligator, Selache, Gecko, Schilbe, Malthe, Mene, Halicore, Erato, Ammonceratites, there being a choice between four terminations for the last, including *ceras*, *cera*, and *cerus*.

If the strictest justice to antecedent authors cannot be obtained by practice, it must be enforced by rule. Number 3 (p. 4) has a partial bearing upon this point, but it requires the addition . . . *with the citation of the original authors.* Some of the Linnæan genera have been drawn upon so largely, that there is literally nothing left. It might be supposed that such genera as Simia, Buprestis, and Lepas, had never been formed, and with the genus, many authors do not hesitate to appropriate the species by self-citation; and as probably no genus or group can stand exactly as the great master left it, *his* name must ere long be blotted from the system which owes to him its existence. The rule as it stands will be of little use, if we are permitted to write Perca, *Cuv.* instead of Perca, *Lin.* It may be said that the genus of Cuvier is not that of Linnæus—perhaps not; but if the former be entitled to it on this account, then is he also entitled to the species; because, although Linnæus had a *Perca fluviatilis*, it is not quite the fish so named by Cuvier, as it does not belong to the same genus!

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* Is *Juli* a singular or plural, genitive or dative? is it from *Julus* or *Julis?* is the latter masculine or feminine, declined like *turris* or *lapis*, should the initial be I or J?

Let us examine this pernicious practice a little further. Lamarck first framed and characterized the genus Ampullaria. Sowerby gave it a different extent by adding the *cornu-arietis*, and would thus have been entitled to it until it appertained to Guilding* by the withdrawal of the same species to form his genus Ceratodes, although this removal restored the genus to the Lamarckian standard. The right of possession, however, is not recognized under barbarian laws; consequently, the discovery and withdrawal of Ampullacera entitled Quoy to the spoils, until they fell into the hands of Swainson by the restoration of Montfort's deposed genus Lanistes; but as it is uncertain whether this should or should not have been done, and as the reigning authority must differ according to the different views entertained of the succession, added to the uncertainty attendant upon revolutionary proceedings, the genus Ampullaria has fallen into a state of anarchy, without authority or patron, the prey to dissentient claimants; and all this after it had been clearly established by Lamarck, who still lives in his works, and in the grateful remembrance of those who appreciate his merits. He is still cited for his genus, but this toleration will be revoked the moment it is conceded to be just to assume the original genus, as well as the subdivisions, when it becomes necessary to divide a group. Some authors appear to possess a monomania on the subject of having their names attached to the species of antecedent authors, undisturbed by the thought that the time may come when every species will be so well known as to require no citation, and the names of the proposers of species of almost as little account as the lists in a city directory.

It would be well perhaps, to add a section to rule 10, (p. 4,) as follows:—*But the author who merely proposes the change, like the corrector of a typographical error, is not entitled to the citation of the genus and species.* If the original author be not entitled to it, it belongs to the world at large (*autorum*). If this rule could be adopted, or depended upon by describers, the deluge of personal and geographical names would be stopped, as they are imposed from the fear that any suitable adjective may have been already (perhaps simultaneously) appropriated in some other portion of the world. It appears an injustice to those who

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* It is not material to my argument whether he or Quoy has priority.

give the best names, that they are liable to lose the slight reward for their labors indicated by a citation, through circumstances beyond their control; whilst the very worst compounds secure the species to their proposers. Why should not an equal security be guarantied to all? Ex. 1. Mr. Hentz described a species of Cicindela, the name might become *C. hentzii*, Autr., although the change was proposed by Dejean. It would subserve a good purpose to restrict the genitive to these cases. The original authority might be cited with a mark (*op.*) indicating that he was the first to publish it in a work, as a species. Ex. 2. The specific name was pre-occupied in Say's *Sciurus macrourus;* Godman, on this account, changes a letter and preserves the old citation, *S. macroureus*, Say. Ex. 3. *Haltica* and *Dyticus* are preferable to *Altica* and *Dytiscus*, but the original citation must stand under either form. *Hemiramphus erythrorhynchus*, Lesueur, belongs to this author, notwithstanding his name stands *erythrorinchus.*

"14. *In writing zoological names, the rules of Latin orthography must be adhered to.*" This has been much neglected, as we find generic and specific names in use, which cannot be represented by the Latin alphabet. A name should not be adopted which cannot be Latinized, or put into an unobjectionable shape. The double *n*, as it occurs in English and German, is inadmissible in Latin; thus Linnæus, Fabricius, and Degeer wrote *pensylvanica*, otherwise, many readers may suppose the *n* to be double, in pronunciation. *Goodenia*, *Goodenoviæ*, are faulty, because the *oo* brings a redundant syllable. *Gudenia* is preferable. Of those cited by Dr. Gould (p. 10) *Le Guillouii* is certainly indeclinable, the *article* is inadmissible, and if Guilloüs be the assumed nominative, *Guilloï* is probably less objectionable. So *Petituarsii* is less unsightly as a Latin word than *Dupetit Thouarsii*. *Eschscholtz* is invincible, nine consonants to two vowels being beyond the power of the language, and no genus should be admitted which cannot be pronounced with the ordinary power of the alphabet; otherwise Chinese characters may claim a place at some future day. The next rule is based upon recent precedents.

*If A describes a new object, and B renames it without reference to what A had done; he is not entitled to the citation, even should the first name happen to be preoccupied.* Because B with less information, would possess an advantage over A, or get an advantage by an accident. Ex. 1. *Buccinum plicosum*, Menke, is *Fusus cinereus*, Say, whose specific name is preapplied. Ex. 2. An English compiler of juvenile books on natural history, ambitious of shining in a wider field, and unable to discover anything new, changed the name of several British birds. One of these was not what he supposed, but happened to be a new species; detected as such, and subsequently published by an English naturalist, who must be cited for the species. Ex. 3. An English naturalist arbitrarily changes what he supposes to be the settled name of an African bird; a French author subsequently discovers that it is a new species, proposes the published name of his predecessor, under his own authority, and is undoubtedly entitled to the species.

*Vernacular names should be entirely discarded, and never quoted.* Vulgar names are confined to single countries, districts, and languages; they cause great confusion, and are a source of continual annoyance to the foreign reader. An author thoughtlessly writes a paper on the identity of the *red* and *mottled owls;* the native reader knows the species, but will the dictionary of the German who reads English, give him the meaning of *mottled owls?* An English reader of a German magazine may find a paper on *Die gemeine Grasmücke* (literally, *the common grass gnat,*) and pass it, not being interested in dipterology, but turning to his German-English dictionary, which happens (an unusual circumstance) to contain the word, finds it to mean *hedge-sparrow*, which is one thing in America, another in England, and a third perhaps, in Australia. But as the authors of German-English dictionaries do not understand natural history, the *Grasmücke* is a very different species from what those who speak English call *hedge-sparrow.* So the bird *Müllerchen* (little miller) might be mistaken for the insect called *miller*, and the dictionary does not contain the word.

Many of the living naturalists of the last century, by the use of vulgar names and synonyms, render their productions unintelligible to more modern authors; and unfortunately, some of the latter have fallen into this error. The edition of the *Règne Animal* now publishing, (which the editors consider it would be "une espèce de sacrilège" to correct,) says: "Les *pagres* diffèrent des *daurades*," etc. and cites "le pagre de la Méditerranée, (*Sparus pagrus*, Lin. Arted.)" leaving the reader to discover the modern name of *Sparus pagrus*, Lin., in a work written with more extended views. In the modern *Atlas* to the same work, the editors shamefully subvert one of the best principles of modern nomenclature. A figure of a true *Mergus* is given on plate 100, as an example of this genus, whilst our *Colymbus glacialis* is named on plate 88 "Grand plongeon (*Mergus glacialis*, Brisson,)" *Podiceps cornutus*, as "Grebe (*Colymbus cornutus*, Brisson,)" and *Gryllotalpa vulgaris*, as "La courtilière commune (*Gryllus gryllo-talpa*, Lin.)" The French names take precedence in capitals, to indicate that they comprise all that is necessary.

To cite authors correctly, the name particularly adopted must be quoted, and if this be in the vernacular, conspicuously heading the description, or engraved upon the plate, the author must be cited for it; but as no one is compelled to cite unrecognized names, such works are liable to remain unnoticed. Yarrell's British Fishes cannot be cited, as he gives no systematic name to the species, and those of other authors are placed as synonyms.

To frame an unexceptionable set of rules, requires the joint labor of from three to six practical naturalists who have written creditable works; each one to be of a different nation, that local prejudices might be avoided. A single author of judgment might, by correspondence, arrive at the state of opinion on the subject, and if his geographical position were such as to throw him into communication with authors of different nations and feelings, he would be the more able to reconcile conflicting views. The varied attainments of Professor Agassiz seem to fit him for such a task, and with the assistance of the Rev. L. Jenyns in England, Fischer de Waldheim in Russia and Germany, C. L. Bonaparte in Italy, and Guérin-Méneville in France, could produce a standard *Codex zoologicus.*

Art. III.—*Mineralogy of New York—comprising detailed descriptions of the Minerals hitherto found in the State of New York, and notices of their uses in the Arts and Agriculture;* by Lewis C. Beck, M. D., Prof. of Chem. and Nat. Hist. in Rutgers College, N. J. pp. 536 4to, with numerous wood-cuts and lithographs. Albany, 1842.

The volume before us is one from the series of reports, published by the State of New York as the result of the late scientific survey. The extent of the state and the variety of its rock formations, give unusual interest to its scientific history, and especially to its mineralogy and geology. So large a proportion of American minerals are numbered among its productions, that the report by Dr. Beck may be considered a national rather than a state work; and the satisfactory manner in which the subject has been handled, renders it an highly important book of reference for the American mineralogist.

Prof. Beck has treated *first,* of the *economical mineralogy* of the state, giving the results of his observations upon the mineral productions useful in the arts: next, in part *second,* he has given a *descriptive account of all its mineral species,* together with detailed notices of their localities and associations. To this is added a short notice of other American minerals, not yet discovered in the state. Our remarks upon Prof. Beck's report will consist principally of facts cited from the work.

The mineral resources of New York are peculiarly well calculated for permanent prosperity. She has her mines of iron, lead and manganese—inexhaustible stores of salt in her salines—marble, abundant, and of many kinds—building material in profusion—limestone for common and hydraulic cement—clays for brick and pottery—and agricultural advantages unsurpassed in the eastern portion at least of our country, with the means at hand in her beds of gypsum, limestone and marl, for perpetuating the fertility of her lands. Excepting coal, which abounds in the adjoining states, she possesses all those important products which afford to the people sure and substantial means of industry and wealth.

*Iron ores.*—The beds of iron ore are inexhaustible, and are distributed in almost every county; the magnetic, specular, argillaceous and hematitic ores are all abundant, and are largely worked.

The magnetic ore however is most extensively diffused and most highly valued. It abounds in the counties of Essex and Clinton on the north, and Orange and Putnam on the south. The specular iron "is found exclusively in the northern part of the state, principally in St. Lawrence County, where it seems to take the place of the magnetic iron, which prevails in the adjoining counties." The argillaceous ore, a lenticular variety, is described as constituting two distinct parallel beds in the western part of the state, extending from Herkimer near its centre to the Genesee River. The beds are usually about twenty feet apart, and one to two and a half feet thick. The brown hematitic iron ore, or Limonite, is mostly confined to Dutchess County, where it appears to be "a part of the great series of deposits which has been traced with little interruption in a nearly northerly direction through the states of Connecticut, Massachusetts and Vermont." —p. 53.

The beds of magnetic iron are some of the most remarkable in the world. The Stirling mine in Orange County covers a surface of more than thirty acres, and the whole deposit of ore is supposed to be full three miles in length; and this is one of a number of equal extent in this county, and others to the north. The ore from the Stirling mine affords about 50 per cent. in the blast furnace; and that from Long mine, in Orange County, affords 62 per cent. of iron in the large way.

The "steel ore" of Duane, Franklin County, was examined by Dr. Beck, who found it no way different from common magnetic iron; and he expresses his doubts whether the steel obtained from it is sufficiently uniform in texture for good cutting instruments.

The specular iron ore of the Kearney and Parish ore beds, St. Lawrence County, yield about 50 per cent. of pig iron, "about twenty six hundred pounds of which yield a ton of wrought iron. The quality of the iron is improved by adding bog ore."

The lenticular or argillaceous ore yields from 30 to 35 per cent. of pig iron, which is mostly used for large castings. Prof. Beck remarks that the result is improved by mixing with the ore, bog or magnetic iron. It generally effervesces freely with an acid, indicating the presence of carbonate of lime. A specimen from Wolcottville afforded Dr. Beck, peroxyd of iron 51.50, carbonate of lime 24.50, carbonate of magnesia 7.75, silica 6.00, alumina 7.50, moisture and loss 2.75. This ore is said to require a higher heat and one third more charcoal than other iron ores.

The hematitic iron of Dutchess County, occurs according to Mr. Mather, in beds situated near the junction of the mica or talcose slate with the gray and white limestone. The Amenia ore bed furnishes about five thousand tons of ore annually, and yields on an average 50 per cent. of pig iron.

"The manufacture of iron was commenced, in the State of New York, at a comparatively early period. It was actively carried on in Orange County for several years previously to the American Revolution. I have, however, no means of determining the extent of the manufacture at that early date. In 1810, the value of the iron manufactured in the state was estimated at $859,895. At that time there were in the counties of Essex and Clinton, one bloomery and twelve forges, at which 259 tons were manufactured, besides 100 tons from the furnaces.* In 1830, the number of iron-works and trip-hammers in the state was 335, of which the Fourth and Fifth Senate Districts contained no less than 176. According to the census returns made in 1835, the number of iron-works and trip-hammers was 434, and the value of the iron manufactured was $4,713,530; being an increase from 1830 of nearly 100 iron-works and trip-hammers, and in the value of iron manufactured of upwards of $1,000,000. In 1840, according to the census returns, there were 306 furnaces, bloomeries, forges and rolling mills; in which 82,654 tons of cast iron, and 58,275 tons of bar iron, were manufactured. The capital invested in these was estimated at $2,113,818. To this should be added $1,806,638, as the value of hardware, cutlery, &c. manufactured."—p. 38.

Dr. Beck states that on account of the rude methods of working the ores, the iron trade has not been as profitable or flourishing as might have been expected. The ores are as good and as abundant as could be desired, and nothing but proper system and the improved modes of smelting are necessary for the most complete success. The continued use of the common forge, as Prof. Beck states, is bad economy, often losing one half the product that a well constructed furnace would afford. The recent substitution of anthracite for charcoal in blast furnaces bids fair

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* Tench Coxe. Statement of Arts and Manufactures in the United States.

to be a most valuable improvement, especially as charcoal is giving out in some portions of our iron country.

*Lead ores.*—The only deposits of lead ore which are worthy of special mention are the veins of Rossie in St. Lawrence County and of the Shawangunk Mountains in Sullivan County. These have already been described in this Journal, and we need not repeat in this place. We cite a few sentences from Dr. Beck with regard to the condition of the Shawangunk mines.

"The mining operations have been carried on in the most judicious manner, all the galleries and levels being susceptible of complete drainage and ventilation. The amount of ore obtained is large, and it is quite probable that it may be increased to any extent, and at a trifling cost. The mineral was reduced in a reverberatory furnace; and the lead, of which many tons have been manufactured, is said to have been of good quality. Both the lead and the ore yield by cupellation a small proportion of silver; too small, however, to warrant the separation in a large way.

"The ore itself, aside from the associates above named, is as rich, as valuable, and as easily reduced, as that of any lead mine whatever. The location of this mine, too, and the prospect of a supply of ore, are all as favorable as could be desired, while the average quantity of ore in a cubic yard of the vein is as great, if not greater, than that of any lead mine at present known in the state.

"The Sullivan and St. Lawrence mines may be thus briefly contrasted. In the latter, the ore is in small veins, with very good associates, and is easily reduced; but the situation of the mines is bad. In the former, the ore is in large veins, with bad associates, and is more difficult of separation and reduction; but the mines are admirably situated, whether we regard the removal of the ore, or the facility of transporting the produce of it."—p. 51.

The associates here referred to, are blende and copper and iron pyrites, the first of which constitutes a large part of the vein. The mines of Rossie have not been worked since 1839.

*Manganese ores.*—Manganese is found most abundantly in the counties of Columbia and Dutchess, where it occurs in marshes and is mostly the bog variety. According to Mather, fifty thousand tons of ore could be obtained at these deposits with little expense. Mr. M. suggests that this bog manganese is derived from the decomposition of brown spar. The deposits occupy a narrow range in the vicinity of a slate rock containing this mineral; and the spar may often be seen under its original form, consisting of manganese, the result of decomposition.

*Hydraulic Limestones.*—Passing by the chapters on Gypsum and Marble, we cite a few of Dr. Beck's remarks on hydraulic limestone. These limestones abound in the state, and, as stated by Mr. Mather in 1839, six hundred thousand barrels of cement were manufactured in Ulster County alone, and much of it shipped for foreign ports. The vicinity of Chittenango affords about one hundred thousand bushels annually.

The hydraulic character of these limestones in general depends on the silica, or silica and alumina or magnesia, which are intimately mingled with the carbonate of lime in the constitution of the rock. The earths are in a finely divided state, and as they are disseminated uniformly through the rock, the particles are in the best condition possible for an immediate combination with the lime, particle to particle, to produce the silicates upon which the strength of the cement depends. A common fault with ordinary mortar is that the sand is coarse, in consequence of which only the exterior of the grain enters into these combinations. But in the hydraulic cement the silica and lime are not only in a finely divided state, but are also intimately mingled, in a manner which art could not imitate without much labor and expense. The hydraulic character has been attributed also to oxyd of iron, manganese, and even soda. Some or all of these substances may improve its quality, but silica appears to be the most essential ingredient. Dr. Beck says:

"It appears from the experiments of Berthier and Vicat, the highest authorities upon this subject, that no mixture, of which silica does not form a part, acquires hydraulic properties; that limes containing only silica or alumina, or better those containing silica and magnesia, acquire a much greater degree of hardness than the silicates of pure lime; and that the oxides of iron and manganese contribute nothing to the hardening of these bodies." —p. 76.

Prof. Beck gives the following as the composition of the hydraulic limestone of Rondout, Ulster County, before and after calcination, (p. 78,)

| | Before calcination. | After calcination. |
|---|---|---|
| Carbonic acid, | 34.20 | 5.00 |
| Lime, | 25.50 | 37.60 |
| Magnesia, | 12.35 | 16.65 |
| Silica | 15.37 | 22.75 |
| Alumina, | 9.13 | 13.40 |
| Peroxyd of iron, | 2.25 | 3.30 |
| Loss, | 1.20 | 1.30 |

and remarks that the calcined product approaches in composition a double silicate and aluminate of lime and magnesia. The following are his analyses of other hydraulic limestones.

| | Schoharie. | Chittenango. | Chittenango. | Manlius. | Grand I. | W'msville. |
|---|---|---|---|---|---|---|
| Carbonic acid, | 40.34 | 38.65 | 40.95 | 39.80 | 41.01 | 37.66 |
| Lime, | 31.75 | 27.35 | 29.00 | 25.24 | 28.79 | 26.11 |
| Magnesia, | 14.91 | 16.70 | 17.30 | 18.80 | 17.70 | 16.48 |
| Silica, Alumina, | 11.50 | 8.95 / 4.90 | 11.00 | 13.50 | 12.25 | 18.45 |
| Peroxyd of iron, | 1.50 | 1.75 | 1.50 | 1.25 | —— | —— |
| Loss, | —— | 1.70 | 0.65 | 1.41 | 0.25 | 1.30 |

Prof. B. remarks, that "the process of burning or calcining the limestone requires great care. A limestone, very proper in other respects, gives, when the heat is urged too high, what is called a *dead lime*, in consequence of the partial fusion of the mass; whereas, when the calcination is effected at too low a temperature, the resulting lime is meagre, and not hydraulic.

"Hydraulic lime should be used as soon as possible after calcination; and when kept for any time, it should be carefully protected from the action of the air. It has been ascertained that the hydraulic property of limes is much weakened by their being exposed to the air; and consequently, all other things being equal, recently prepared hydraulic lime is to be preferred for important structures, to that which has been for some time manufactured.

"It is generally agreed that the rapidity with which hydraulic mortar hardens, and the ultimate degree of hardness which it acquires, depend greatly upon the proper proportions of lime and sand, their intimate incorporation, and the amount of water employed in their mixture. All these are points which must be settled by previous experiments."—p. 77.

In Ulster County, where the hydraulic limestone abounds and is largely worked, the following is the mode of preparation.

"The limestone is first reduced to small fragments, which are then thrown into a kiln with layers of the screenings of anthracite intermixed. At an interval of twelve hours, the lower layers of the kiln are removed, and fresh portions of the limestone thrown into the upper part. These operations are so managed that each layer is subjected to heat for about three days. The lime thus calcined is of a light drab color; and when reduced to powder and mixed with about one third its bulk of sand and made into a paste with water, soon becomes hard. The grinding is performed in a mill, and the powdered cement is put up in barrels which are lined with paper to prevent as much as possible the access of air."—p. 77.

In the following chapters, Dr. Beck treats of the marl deposits, and the brine and other mineral springs in the state, which we need not notice here, as the principal facts have already been stated in this Journal. With regard to the origin of the salt in the Brine Springs, Dr. B. argues that there are beds of rock-salt below, from which it is dissolved, and opposes the view that salt is disseminated in particles through the rock. Both suppositions may be true; like lime, salt may be disseminated in beds or in grains, and in either case might give origin to brine springs. Both sources probably exist in the state of New York. Leaving these discussions without further remark, we pass on to

Part II, entitled Descriptive Mineralogy, which includes complete descriptions of all the various minerals of the state. The specific characters of each species are given as in common mineralogical treatises. This is more than should have been expected in a state report; but it renders the work more complete in itself and more convenient for those who have not other general works on mineralogy at hand. A large number of crystalline forms is given. But a small proportion of the figures, however, are new, and much yet remains to be done in studying out the more complex crystallizations of some of the New York minerals. Very many of the forms, although before known, are for the first time identified in any work, with the different localities in the state, and much useful information is thus conveyed. The localities are described with great fidelity, and whatever pertains to the habits of the species, their accidental variations and mineral associates. In addition a number of new analyses are given.

The number of species detected in the state is one hundred and fifty. In the following remarks it will be most convenient to follow the course of the work, and extract such facts under the several species as may be new.

One new species, proposed by Prof. Beck, we may first notice. It is named *Hudsonite.* It belongs to the augite family, and as Rammelsberg remarks of the closely allied mineral, Polylite, (Handwörterbuch, II, 69,) it is near the variety Hedenbergite. In cleavage and angles it resembles a massive black augite. H.=4·5—5. G.=3·5. Lustre vitreous, resinous, opaque. Before the blowpipe it fuses with effervescence to a black bead, attractable by the magnet. Composition according to Prof. Beck, silica 37·90, oxyd of iron 36·80, alumina 12·70, lime 11·40, magnesia 1·92. Except in the absence of oxyd of manganese, it differs but little from Polylite. It was found by Dr. Horton in a vein of quartz in the town of Cornwall, Orange Co. The Polylite of Thomson is stated to have come from Hoboken; but Prof. Beck remarks that this must be an error, as no bed of magnetic iron ore, in which it was said to occur, is known to exist there.

The *Eupyrchroite* of Prof. Emmons, is shown by Prof. Beck, to be a mammillated phosphate of iron, and the *Chiltonite* of the same author, to be Prehnite. The Rensselaerite is shown to be a steatitic pyroxene, quite similar to the steatitic pyroxenes of Sahla, analyzed by Rose. Its crystallizations, when distinct, have the form and angles of pyroxene. On analysis, Prof. B. found a specimen from Canton, St. Lawrence Co., to consist of silica 59·75, magnesia 32·90, lime 1·00, peroxyd of iron 3·40, water 2·85. It fuses with difficulty before the blowpipe to a white enamel. It occurs of white, gray and green colors, often dark or even black. The light colored varieties are sometimes translucent. H.=3—4. G.=2·874. It is easily worked in a lathe, admits of a neat polish, and is wrought quite extensively into inkstands, &c.

We proceed with the species in the order of the work.

*Heavy Spar.*—At Schoharie, heavy spar is mechanically mixed with strontianite and carbonate of lime. The calstronbaryte of Prof. Shepard is one of these mechanical compounds. (p. 207.) At Carlisle also a fibrous heavy spar contains largely of carbonate of lime, and "in some places seems to pass into fibrous carbonate of lime, by almost insensible gradations." The fibres are from a quarter to an inch and a half in length and have a lustre between resinous and pearly.

*Strontianite.*—"The Emmonsite of Dr. Thomson is certainly nothing more than a mechanical mixture of carbonate of strontian and carbonate of lime."—p. 213.

*Calc Spar.*—The Rossie lead mines and other places in the vicinity have afforded splendid crystallizations of calc spar. "Crystals have been obtained twelve inches in diameter, with all the sides perfect," p. 224; one in the cabinet of B. Silliman, Jun. weighs one hundred and sixty five pounds, and although a cleavage crystal in part is finely modified on several of its angles and edges. Prof. Beck has given a number of the simpler forms from this region. The accompanying figure, (fig. 1,) by the writer, represents one of the more complex, not of unfrequent occurrence. The crystals are very commonly rhombohedrons, with a few planes on the edges and angles. The scalene dodecahedron, simple or modified, is another frequent form. They are often compounded parallel with the terminal plane, and also with a prismatic plane on the lateral angles, and some crystals consist of six individuals thus combined. Crystals are occasionally observed in which the terminal plane of the modified rhombohedron, has been covered

Fig. 1.

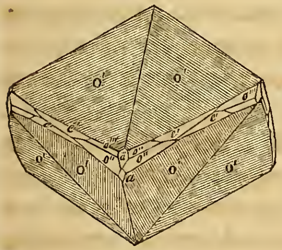
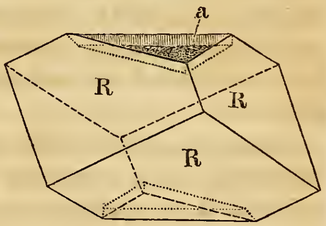


Fig. 2.




with a layer of pyrites, and afterwards built upon by subsequent crystallization, until the rhombohedron was completed and the plane wholly obliterated. The writer is indebted to Prof. Emmons for the examination of a specimen of this kind. Prismatic specimens are not uncommon in which the terminal pyramid (the primary faces) has been similarly incrusted with pyrites and then covered again with crystallizing lime. Another singular effect of intermitted crystallization is represented in the annexed figure, (fig. 2.) In these crystals, the plane a is bordered by an elevated rim, a twelfth of an inch or so high. The crystal after an interval in which the process of crystallization was suspended, commenced again to enlarge—owing perhaps to a new supply of the calcareous solution:—but at this time the crystal is so changed in condition, or in its attracting influences, that the laminæ added to the rhombohedral faces, were no longer modified as before, and consequently, instead of enlarging the face *a*, they extend above it, and form a border around it. The calc spar of this region is often transparent and presents yellow, rose and amethystine tints in addition to the more common shades.

*Apatite.*—The apatites of St. Lawrence Co., are remarkable for their size. One from Hammond measured nearly a foot in length and weighed eighteen pounds. The crystals are usually the six-sided prism with simple pyramidal terminations. Very often the faces and edges are rounded, and some crystals are curved or bent. Deep and pale green and blue are the common colors.

*Magnesian Carbonate of Lime.*—Prof. Beck found the *Pearl spar* of Lockport, to consist of carbonate of lime 59·00, carbonate of magnesia 39·50, carbonate of iron 1·50. The variety called *Gurhofite* from Phillipstown—a white compact rock, having a semi-opaline appearance and a fracture like porcelain, consists of carbonate of lime 66·75, carbonate of magnesia 26·50, silica 6·75. An allied variety from the Quarantine, Richmond Co., gave carbonate of lime 52·75, carbonate of magnesia 42·25, insoluble matter chiefly silica 5·00, with traces of oxyd of iron. Sp. gr.=2·712. It is a tough rock and is difficult of solution, except when finely pulverized.

*Magnesite.*—Under this name Prof. B. includes the marmolite of Nuttall, which is properly a foliated serpentine, as it is identical with it in composition; also kerolite and meerschaum. A mineral from Westchester sometimes labelled kerolite, presenting thin brittle plates of a white or green color, subtranslucent and somewhat resinous in lustre, afforded him, silica 40·50, magnesia 38·00, water 21·00, with a trace of iron. This composition agrees nearly with that of serpentine, of which this mineral appears to be a variety. Another specimen from the Quarantine, Richmond Co., where it occurs in thin seams in serpentine, gave nearly the same composition. A variety from Stony Point, Rockland Co., afforded him, silica 37.40, magnesia 32.56, oxyd of iron 10.05, water 14.60, alumina 5·35, with a trace of oxyd of manganese. It occurs with other magnesian minerals in trap, forming narrow veins of dull white grayish and greenish colors. It is infusible except on the thinnest edges, which become rounded and the color of the mass lighter. Prof. B. suggests the name Rocklandite for this mineral, if received as a new species.

*Hornblende, Pyroxene.*—A large number of interesting localities of these species are given by Prof. Beck. We refer to his work for them, and notice here only one or two hornblende pseudomorphs. One from Warwick, having the form and cleavage of hornblende, resembles steatite in *feel* and *hardness*. The crystals are six-sided prisms with dihedral summits, and are sometimes bent and distorted. Prof. Beck found them to consist of silica 35·00, alumina 32.33, lime 10.80, magnesia 20.70. They occur in limestone with mica, fluor and chondrodite. These crystals are "probably hornblende altered by an intrusion of alumina and a removal of part of the silica. The contorted and somewhat fused appearance of many of the crystals clearly point to heat as the agent by which these changes have been produced." Prof. B. asks, "may not the chondrodite have been formed by the combination of the silica which these crystals have lost, and the fluor from the decomposition of the mica?" mica having also contributed, as he before suggested, to furnish the additional alumina.

Another pseudomorph in long rhombic prisms with the angles of hornblende, and presenting a grayish green color, with the softness of talc, afforded Prof. B. silica 34·66, alumina 25·33, lime 5·09, magnesia 25·22, water 9·09.

*Hypersthene.*—Prof. Beck finds on analysis, that the hypersthene of northern New York, differs little in composition from common pyroxene. He obtained for a specimen from near Ticonderoga, silica 45·45, lime 24·33, magnesia 18·00, oxyd of iron 11.49.

*Idocrase.*—The *xanthite* of Warwick, has the crystalline form and composition of idocrase, and there is no doubt of the identity.

*Feldspar* and *scapolite* occur under a great variety of forms and in crystals of unusual dimensions; but we pass on, referring for an account of them to Prof. Beck's work.

*Stellite.*—The mineral from Bergen Hill, supposed to be the same with Thomson's stellite, consists according to Prof. B. of silica 54·60, lime 33·65, magnesia 6·80, oxyd of iron and a little alumina 0·50, water and carbonic acid 3·20.*

* See Dr. Beck's article on the minerals of Bergen Hill, in this Journal, Vol. XLIV, p. 54.

*Clintonite.*—This mineral is the Seybertite of Clemson and Holmesite of Thomson. It was named Clintonite about fifteen years since by its discoverers, Messrs. Finch, Mather and Horton, in honor of De Witt Clinton.

*Zircon.*—Highly interesting crystals occur at Hammond, St. Lawrence Co., and Johnsburg, Warren Co. Some of the prisms are an inch and a half long, and half an inch through. They sometimes contain a large proportion of carbonate of lime, and occasionally the crystals have a tesselated structure, somewhat resembling chiastolite, the faces being white except the angles, which are a rich brown. The annexed figure, (fig. 3,) represents a crystal of this kind; the crystals are white excepting the part about the angles within the dotted lines. The plane *o′* is absent from part of the angles, owing to the extension of the other planes. Some crystals have a nucleus of carbonate of lime. The longer prismatic crystals are often bent or broken in the rock.

Fig. 3.

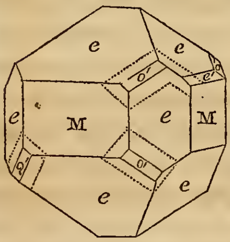



Fig. 4.

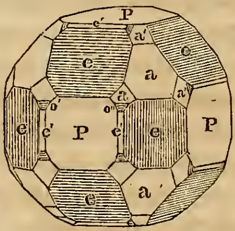
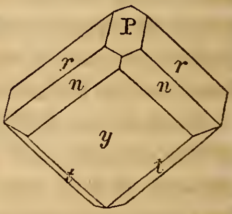



Fig. 5.




*Iron Pyrites.*—Interesting forms of pyrites occur at Rossie, some of which are figured by Prof. Beck. Figure 4, by the writer, represents a brilliant crystal from that region, an inch in diameter, in the possession of Prof. Emmons.

*Sphene.*—This mineral is abundant in the counties of Orange, St. Lawrence, Jefferson and Essex. In Warwick the crystals are sometimes nearly two inches in breadth. A variety from Phillipstown in Putnam Co., Grenville in Upper Canada, Natural Bridge, Lewis Co., and elsewhere, has been described by Prof. Shepard as a new species, on crystallographic considerations, by the name of *Lederite*, under which name it is referred to by Beck. The accompanying figure, (fig. 5,) represents the crystal figured by Prof. Shepard, reversed in position; by comparing it with figure 229, (a crystal of sphene,) in the last edition of Mohs, it will be found to be identical, except that the latter has a few additional planes. Moreover there is but little difference in the angles as given by Prof. Shepard, and none as far as is known, in composition.

*Allanite.*—The allanite of Monroe, Orange Co., where it occurs massive, of a brownish black color, resinous and submetallic lustre, gave Prof. B. on analysis, protoxyd of cerium 24·90, silica 30·50, alumina 11·25, protoxyd of iron 22·27, lime 9·87.

J. D. D.

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Art. IV.—*A Catalogue of the Reptiles of Connecticut, arranged according to their natural families;* prepared for the Yale Natural History Society, by Rev. James H. Linsley, A. M.

To the Secretary of the Yale Natural History Society:

*Dear Sir*—I herewith transmit to the Society a list of the *reptiles* of Connecticut, as far as ascertained, and as my efforts to make it complete have been extensively exerted, it is believed very few, if any more species will soon be obtained in the State.

I would take this opportunity to tender my thanks to those gentlemen who have from various towns kindly favored me with specimens, and to those who have informed me of localities of some rare species, to which reference is occasionally made in the notes of this catalogue. My thanks are also especially due to Professor Silliman and Son, for the free access at all times to their valuable libraries, and for the loan of such books as I could not otherwise obtain, not only on this, but every branch of natural science, to which my attention has been directed.

The notes in the following list are somewhat extended, but it is hoped they will not be found altogether uninteresting.

It was my intention to have accompanied this with catalogues of the fishes and shells of Connecticut, both being nearly ready, but it is desirable to establish some undecided points with regard to a few species. My hope is to complete them both in the course of this year; and specimens and communications relating to the discovery of any new species in the zoology of Connecticut, will be acceptable.

Generally in this list, as well as in those which have preceded it, the old names have been preferred, where as it seemed to me no permanent good would be obtained, by the use of modern synonyms. I hope however the article will be not the less interesting on that account. It is mentioned here merely by way of explanation.

## CLASS III. REPTILES.

### Order TESTUDINATA.

### Family *Chelonidæ.*

*1. Chelonia mydas, Linn., Green Tortoise, Stratford.
*2. Chelonia? ——— ? Long Island Sound, New London.

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*1. An individual of this species was taken a few years since by a shad seine, seven miles up the Housatonic; length about 2 feet, and 1½ feet wide—was kept several weeks confined in a pen made in the river, at the lower wharf in this village, about three miles from Stratford Point. It was fed on vegetables, such as cabbages and various esculents from the garden, with an idea of making him fat for the table, but he refused to eat, and finally died, though confined in salt water. From the film over the eyes, he was evidently sickly when taken, as this is always a *symptom of disease* in the whole family.

Another individual of this marine tortoise was taken by a harpoon a few years since at the mouth of the Housatonic, and the upper shell somewhat injured was preserved and sent to me by Mr. Sidney Beardsley of this town. Length of shell 17 inches, width 15 inches. It perfectly agrees with a figure of the *C. caretta* in "*Catesby's History of Carolina, Florida, and the Bahama Islands,*" and is very unlike Dr. Holbrook's figures of either species; but not satisfied with a work of 1772, I forwarded it to Dr. Storer for the Boston Society of Natural History, and "after comparing it with several specimens of different ages and different localities, I am satisfied," (writes Dr. S.) "it must be the *mydas.*" This species is very rare, but occasionally an individual is taken at Stonington and New London, as well as Stratford.

*2. Mr. Wm. G. Buell of Chatham in this state, informs me that "about ten years since there was a tortoise taken in the Sound near New London, by two men in a fishing smack. They first struck it with a harpoon in the fore part of the shell, and though it made a gash 12 inches in length, it was so hard it turned off, and they feared they had lost him; but they had another good throw of the harpoon into the neck as he rose at the bow of the smack, and secured him. It was afterwards exhibited in an ox cart, and thus conveyed about the country for a show. Mr. B. thinks it would weigh from 500 to 700 pounds. Shell 4 to 5 feet long, and flippers 3 to 4 feet." I imagined it might have been the Leather Tortoise, No. 3, and showed him the figure of it, but he was "sure it was not that shape, but nearly round like our common speckled turtles." It had a rudder for a tail about a foot long, shaped like a scow rudder, (i. e.) wide and flat perpendicularly. His mouth was filled with little pipes like porcupine quills, and he evidently lived by suction through these quills. He thinks it was not the shell tortoise, *Chelonia imbricata,* Holbrook. I addressed a line of inquiry on the subject to a young friend in Stonington, (Mr. Trumbull,) and in reply he writes: "Of the monstrous turtle taken in Long Island Sound about ten years since, I have a faint recollection, as exhibited at a military review, at which I chanced to be present, but did not see it, nor can I say any thing of it, or of its capture, with certainty." This is all I can learn respecting it hitherto. It is inserted here with earnest request that if it meets the eye of any person who can give a just account of it, and of its specific name, &c. he will please do so for the benefit of science.

*3. Sphargis coriacea, Mer., Leather Tortoise, Long Island Sound.

*4. Testudo palustris, Linn., Terrapin, Housatonic River.

*5. Emys terrapin, Schœpff., Smooth Terrapin, Stonington.

*6. Emys picta, Schneider, Painted Tortoise, common.

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*3. Cuvier, (Vol. II, p. 10, Am. ed.) says, "Merrem has recently distinguished by the name of *sphargis* those Cheloniæ whose shell is destitute of plates, and merely covered with a sort of leather, such as the *Testudo coriacea* of Linnæus." Dr. Dekay, in his report on the zoology of New York, page 5th, says: "A fourth specimen [found on our coast] was taken Sept. 7, 1826, in Long Island Sound." Dr. Storer, page 217 of his Report to the Legislature of Massachusetts "on the fishes and reptiles of that State," describes a specimen taken in Massachusetts Bay in 1824, of which he gives a good figure by Dr. Wyman. Length, 85 inches, widest part 14 inches. His leathery covering was 57 inches in length. These proportions are mentioned here as very extraordinary for any species of tortoise—over 7 feet long, and little more than a foot wide! Our Connecticut specimen is believed to have been of no less dimensions.

*4. This is the *Testudo concentricus* of Shaw. I had a specimen of the upper shell from Cheshire in this State, which measured 8 inches long, and 6 wide, which I forwarded to Dr. Storer, Boston. I have had also two specimens of the living animal from the Housatonic this season, of the same dimensions. Dr. Shaw, page 43, Vol. III, says, "they are from 4 to 6 inches long. But Dr. Brown describes them as 8 or 9 inches long in Jamaica—are sold in Philadelphia market as terrapins." They are in my estimation superior to any of the genus for the table. The fact that they are common in Cheshire, about 14 miles not only from salt but even *brackish* water, evinces that Dr. Dekay is mistaken in his assertion on page 11, of his Report, viz. "It is well distinguished as the *salt-water terrapin*, for it is found *exclusively* in salt or brackish streams near the sea-shore." He also adds, "geographical limits from Mexico to New York, and northern shores of Long Island." This and the following species were for a long time considered the same. Major Le Conte, however, who is considered good authority in herpetology, saw females of both of the same size, and considered them different. (See Dr. Dekay's Report, Part III, p. 11.)

*5. Dr. Holbrook says this species is found as far east as Rhode Island. I have obtained the shell of a young specimen from Mr. J. H. Trumbull, taken at Stonington, which exhibits the principal difference between this and the preceding, as noted by Dr. Dekay; and it agrees much better with Dr. Holbrook's figure, than with my specimens of the preceding species. It has but one half as many concentric lines on the lateral plates; and the last dorsal plate is much larger, and unlike in shape to the same plate in the preceding species. How much is to be ascribed to the difference arising from age, I believe is not stated, though I doubt not I have the shells of what are considered the two species, and both found living in Connecticut waters.

*6. This species is found in most of our brooks and ponds of fresh-water. I picked up a specimen in this town in 1842, which was crossing the road, and found it marked "1821;" being 21 years since its mark was received, and its general appearance evinced the probability it was marked at the time named. I preserved it for my cabinet, and the shell measures 5 inches in length and 3½ in width, about a medium size.

*7. Emys guttata, Schneider, Speckled Tortoise, common.

*8. Emys insculpta, Le Conte, Wood Tortoise, Stratford and Hartford.

*9. Sternothærus odoratus, Bosc., Musk Tortoise, Stratford, East Hartford, and Stonington.

*10. Chelonura serpentina, Linn., Snapping Tortoise, common.

*11. Cistuda clausa, Schœpff., Lock Tortoise and Box Tortoise, common.

*12. Cistuda Blandingii, Holbrook, Blanding's Tortoise, Darien.

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*7. Both this and the preceding species are nearly round, until about half grown, and are so unlike in shape to the adults, that were it not for the external markings upon the shells, they might easily be taken for other species.

*8. The first specimen of this species I received from Cheshire by the hand of Benjamin Brooks, Esq. of Bridgeport. Length of shell 6½ inches, width 5 inches. Since then, I have taken it in the Housatonic near Derby, and find it not very rare. Mr. S. Crofut of Derby assured me that he once laid one of these tortoises on its back upon a rock, and laid a stone on it to retain it in that posture, and three weeks after he found it in that situation as he left it, but apparently as lively and well as ever. He then turned it over and put on the stone again; and after a great length of time had elapsed, having forgotten it, he found it as well as ever, and then released it. It hobbled off quite satisfied with the opportunity so to do. Though this savors too strongly of cruelty, it evinces a wonderful capacity of the animal to sustain life under these very trying circumstances.

*9. I took one of this species in the Housatonic, Sept. 20, 1841, and another in Trumbull, July 25, 1843,—the only specimens I recollect to have seen, and it may therefore be considered rare. It is the smallest of all the family inhabiting New England, at least as yet discovered.

*10. This species is quite common throughout the state, and is much used as an article of food, and is at times found very large: one taken at Stonington in June last, measured 37½ inches; shell 16½ inches long and 13 inches wide, and weighed 23½ pounds. Another has since been taken there which weighed 28 pounds, as Mr. J. H. Trumbull informs me.

*11. This is the most beautiful of all the race of tortoises in our country, and the only one with which I am acquainted that is found habitually on land. They live to a great age, if we may trust the markings and dates, often found on their under plates, of which in most instances we have no reason to doubt. I found one some time since, that I had marked when a small lad,—the number of years I do not now recollect, as I then hoped I might be favored to find him again in years subsequent. The covering to this shell is such as to render marking easier and more distinct than that of any other species, and evidently causes the animal no suffering more than even paring the nails. A specimen before me measures 6 inches long, and about 4½ wide—a medium size.

*12. This tortoise, called by Dr. Dekay *Blanding's Box Tortoise*, is found both east and west of us, (Massachusetts and New York,) it is therefore doubtless an inhabitant of Connecticut. In August 2, 1843, I saw mounted on a stick projecting from a small pond in Darien in this state, a tortoise I took to be this; I came so near as to be on the point of laying my hand on him, when he slid off

### Order II. Sauria.

#### Family *Scincidæ.*

*13. Scincus fasciatus, Linn., Blue-tailed Skink, Salisbury and Trumbull.

#### Family *Agamidæ.*

*14. Tropidolepis undulatus, Bosc., Brown Swift, Pine woods.

### Order III. Ophidia.

#### Family *Colubridæ.*

15. Coluber sirtalis, Linn., Striped Snake, common.

*16. Coluber saurita, Linn., Ribbon Snake, Stratford and Stonington.

*17. Coluber ordinatus, Linn., Little Brown Snake, Stratford, Stonington and Bridgeport.

*18. Coluber vernalis, Dekay, Green Snake, Stratford, Northford and Canaan.

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and escaped to my great regret. I believed it certainly this, or the preceding species, to which it is nearly allied; and as I have never seen the latter in water, it was probably the true *Blanding's Tortoise.* It was to me a little remarkable, as being the same place where I obtained the *Sorex parvus* mentioned in this Journal, Vol. xxxix, p. 338. I then supposed the place to belong to the town of Stamford, but have since ascertained it belongs to Darien.

*13. Frederic Plumb, Esq. of Salisbury, Litchfield County, a gentleman of much observation, assures me he has often seen this beautiful animal in that town; and Mr. Benjamin Beers of Stratford, lately saw several in Trumbull, while he was pulling down an old building.

*14. The *brown swift* has, according to Dr. Dekay's recent "Report on the Zoology of New York," been found in both Dutchess and Putnam counties; and as these join almost the whole western line of Connecticut, it scarcely admits a question that the animal has just claim to insertion here; especially too as its habitat is from the Gulf of Mexico to the 43d degree of north latitude. I have no specimen of this family belonging to North America, except *Phrynosoma cornuta*, of Holbrook, commonly named "*the horned toad with a tail;*" received from Texas, where it is not uncommon, but is here considered a great curiosity.

*16. This species of striped snake is much less common than the preceding; is more slender and more resembles a whip-lash. The distinction between the two, is not generally known, except by naturalists. Both harmless, and feed on toads and frogs.

*17. The grass snake or little brown snake is not uncommon in Stonington. Mr. Trumbull informs me that he has taken three individuals this season. The Hon. Daniel Plant of Stratford, believes he killed a specimen of this snake in his garden, March 22, 1842. I have two fine specimens taken this season in Bridgeport by Mr. E. Thompson.

*18. I received a specimen of the *green snake* August 13th, 1843, from Mr. Charles Wells of this town, which he had recently killed here. Length 11 in-

*19. Coluber punctatus, Linn., Ringed Snake, Northford and Hartford.

*20. Coluber constrictor, Linn., Black Snake, common.

*21. Coluber Alleghaniensis, Holbrook, White-throat Racer, Northford.

*22. Coluber sipedon, Linn., Black Water Snake, common.

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ches. I once saw a much longer individual of this species in Northford. Mr. William G. Buell of Chatham, informs me he has lately seen one in that town, and on visiting Litchfield County recently, I find it is not uncommon in the northern parts of the state.

*19. I have taken many individuals of the ringed snake at Northford, New Haven County. Mr. Wm. O. Ayres, an enterprising naturalist of East Hartford, informs me, that he has seen one in that town the present season. Since writing the above, I have seen a fine specimen at Darien, in this county, and heard of several others. They are found under stones and more commonly under large clods in new ploughed fields, and sometimes under the bark of decayed trees. Length about 12 inches. Color bluish brown, with a white band around the neck. These remarks are made here in order that it may be easily distinguished from the *racer*, which is much longer. A gentleman in North Canaan lately informed me that one of the large black ringed snakes, mentioned below, chased him I think about sixty rods, and he then turned back upon him and killed him.

*20. The common black snake is quite destructive to young birds. I have seen him entwined around the bushes of the *Cephalanthus occidentalis*, (button bush,) on which the red-winged blackbirds usually build their nests; and thus he gorged a whole nest full of young birds, nearly ready to fly; while a large flock of the old birds were pouncing down towards him in agonies at his cruel depredations.

*21. I have seen and killed many of the long *white-throated racers* in Northford from four to six feet in length. It is the most fleet and sprightly of the whole family in our state. It usually frequents hills and mountainous situations. I have seen one when greatly irritated bite his own back. But it is not poisonous. I have seen the striped snake (No. 15) do the same and with most manifest malignity. They *strike* with the upper jaw, rather than bite. As it is so long since I have seen the *white-throated racer*, I cannot be positive it is this species. The *carinate scales* would at once determine the point.

*22. The black water snake often manifests a disposition to bite and occasionally does so. One instance has been known to me in which the body of the snake was severed in two by a scythe; the head portion was about a foot in length, and it then bit the mower in the foot, (on the instep;) it swelled badly, was troublesome for a length of time, though I believe no remedies were used to alleviate it, as it was correctly believed not to be dangerous. They occasionally climb trees to a considerable height, say ten or twelve feet, and crawl out upon a limb and hang over water, for what purpose I have not ascertained, though I saw one in this county either leap or fall from an extended limb of a large tree into the water, on driving my horse into the water to drink. He appeared quite agitated, and escaped in the water, notwithstanding all my efforts to take him. I took one of these snakes in Stratford recently, endeavoring to swallow the *Rana halecina*. He had seized the frog at right angles between the fore and hind leg; the frog appeared perfectly quiet, and a blow from a stick, on the snake, released him.

*23. Coluber getulus, Linn., Chain Snake, Milford.

*24. Coluber leberis, Kalm, Yellow-bellied Snake, Orange and Canaan.

*25. Coluber eximius, Dekay, Milk Snake, Huntington and East Hartford.

*26. Coluber amœnus, Say, Red Snake, Preston.

*27. Coluber Dekayi, Holbrook, Dekay's Brown Snake, Stratford and Canaan.

*28. Coluber occipito-maculatus, Storer, Stratford.

*29. Heterodon platyrhinos, Holbrook, Flat-headed Adder, Stratford.

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*23. I am informed by Mr. Nettleton of Orange, that he has seen the *chain snake* in Milford. As he is an observing man, possessed of good judgment and quite a taste for natural history, I have inserted it here. I am also induced so to do, from the fact that this as well as the following species are both found near New York and on Long Island. (See Dr. Dekay's Report on New York Fauna, Part III, page 37, with figures.)

*24. Mr. Nettleton assures me that he has killed the *yellow-bellied snake* in the town of Orange. He so decided on seeing Dr. Dekay's figure of this species, to which I had called his attention. Mr. Lawrence also of Canaan, Litchfield County, an observing gentleman, is sure he has killed this snake in that town.

*25. I killed one of this species in Huntington about a year since, two feet two inches in length. It is doubtless found in all our counties. It sometimes in this county has been known to enter a grist-mill and remain a length of time for the apparent purpose of feeding on the mice which were there attainable. It is probable this is one principal object of his frequenting dwelling houses, and not always for the purpose of obtaining milk, as is generally supposed.

*26. The little red snake has been killed this season in the town of Preston by Mr. J. H. Trumbull. It is by no means common, although found in other sections of this state. His specimen was eight inches in length.

*27. The little brown snake is supposed by description to have been killed by Col. Edwards Johnson, at his residence in this town, in the summer of 1841, and in August, 1843, was killed by Mr. Munson in Canaan. It has been found in Massachusetts, Long Island and Michigan.

*28. I have seen several of the spotted neck snake here in autumn, usually nine to ten inches long, turned out of ground where they had evidently intended to pass the winter.

*29. This adder is not very uncommon. I have killed many of them in Northford and other parts of the state. Mr. Wm. O. Ayres has killed one this season in East Hartford. One was killed here last season while floating down the Housatonic, probably in the water by accident, as they do not frequent the water. The hiss of this snake is almost equally loud and certainly more threatening than that of a goose. Mr. Trumbull mentions a specimen taken near Stonington about four feet in length, and says it is there called a *red snake* and is often confounded with the chunk-head, and supposed by some persons to be a new species. This length indeed is very uncommon.

## Family *Crotalidæ.*

*30. Trigonocephalus contortrix, Linn., Copper-head, Stratford, Hartford and Litchfield.

*31. Crotalus durissus, Linn., Banded Rattle Snake, Weston.

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*30. The *copper-head*, called also *chunk-head*, *red snake*, &c. is occasionally found in most parts of Connecticut. One was killed in Stratford this season, two in Trumbull, one in Litchfield, &c. I saw one some years since in Northford, which was found stretched at full length under a fruit tree, where a child had been passing around for fruit. I should judge he was at least two inches in diameter. Mr. Benjamin Beers of Stratford, who informed me of the two individuals of this species killed this season in Trumbull, says his father was bitten by one, and though very dangerously ill, was cured by drinking horehound (*Marrubium vulgare*) and applying it to the wound. The father said that every thing he put in his mouth after the wound of the snake tasted sweet. Mr. B. has often made this species of snake bite a white rag tied at the end of a pole or stick, and says the rag is instantly colored green, extending to the size of a cent. While harmless snakes are always still at night, this snake, as well as the rattlesnake, is found as active as at any time in the day.

*31. The rattlesnake is not common in Connecticut, though found perhaps in more than half the towns in the state. There is a large den of them in Weston. I have seen a few specimens in Litchfield County, uncommonly large. We have but one species and that much less common than formerly. But in Georgia and Florida there are four or five species of this dreaded animal. The *C. adamantius* of Holbrook is found from six to eight feet in length. These are often killed by common deer, which leap on them with all four feet touching each other and off so quick that the snake has no power to bite, and this the deer repeats until he completely despatches him. Mr. George Walter assures me that he witnessed this fact this season in Missouri, while secreted in the bushes near the operation.

Capt. Richard F. Floyd of Georgia, quite distinguished as a naturalist and a great observer of this genus of animals, has tried many experiments upon them, some of which are very interesting. He had several individuals of living rattlesnakes, one of which was seven feet eight inches in length, (of the *adamantius* species probably.) He wrote to me that it was confined in a barrel seven weeks, during which time it neither ate or drank. During its confinement the barrel was placed in the farthest corner of a large room, and although (he says) "I made very frequent attempts to approach the barrel stealthily, both by day and by night, I was unable to get nearer than the entrance of the door, without its rattling. I tried it in stocking feet in the most silent and cautious manner, but always with the same results—its rattles always proclaiming its knowledge of my approach, and increasing from at first a slow measured shaking to their full play, as I came nearer its prison. Rattlesnakes seem however to vary much in their dispositions, and I have seen them in one or two instances, when at large, that could neither be provoked to rattle or coil, (their coiling and rattling being generally simultaneous,) but would use every means to escape." [I suppose this fact arises from a consciousness of deficiency in their poisonous secretions at the time.] "Among other experiments, we made one with a young alligator two and a half feet long. It was placed near the snake and made every effort to turn and escape, and evinced much alarm. Upon its being forced within striking distance, the snake bit it twice upon the head. In one minute after, the alligator appeared to be in a stupor, much resembling their torpor during winter. It was then placed in water, and remained with the wounded part above the surface in one position for an hour, when it expired. On examination, one of the fangs was found broken off in the tough head of the alligator. Thus was a doubt cleared up respecting the effect of snake poison upon this amphibious animal, that they are not exempt from its deadly influence. I have seen many hounds bitten by the rattlesnake, and never knew but one to recover, and that was bitten in October, and was always puny and miserable afterwards. In one instance, a dog lived but two minutes after being struck, (and that was in July,) although I have known some to survive from one hour to one day. But the result depends much upon the season of the year, which seems to have a powerful influence in regulating the venom of all snakes.

"It has been a current opinion that the rattlesnake possesses the power of contraction to such a degree as to defy the strongest man to hold it in his grasp, or to keep his hands asunder. I was induced to try it with one seven feet long. Having secured its head to enable me to seize it, I grasped it with one hand tightly around the neck immediately below the head, and with the other far below the middle; its head was then released. Although its power did not bring my hands together, still by slow degrees, it crowded through my hands in spite of my utmost pressure, until its head had gained a distance that made it unsafe for me to hold on any longer. During the time I held it, I felt an indescribable faint sickness from its horrible smell, and the cold *creeping* sensation it produced upon my nerves. The rattlesnake no doubt [in reply to some queries I had written him, Capt. F. adds] has the faculty to throw off or suppress a disagreeable effluvium. Soon after I had cast away the snake I regained my usual feelings."

Again, after stating his disbelief in the power of this snake to *charm*, he adds: "That they do entice their prey within their reach by some indescribable attractive power is possible, but I have never witnessed it; I have often drawn near the rattlesnake and looked it steadily in the eye until the intensity of my gaze became confused and dim from the most natural cause, without having any strange effect produced upon me. From the great number I have seen from time to time in our forests under a variety of circumstances, I am induced to discredit the power or *inclination* of the rattlesnake to charm man or any animal which is too large to supply its appetite. Still I doubt not that they possess some undefinable alluring power as above remarked, in securing their food; for otherwise how could they so frequently overtake the timid and *fleet-footed rabbit*, the *agile squirrel*, or the *aerial mock-bird*, all favorite repasts with the rattlesnake, which is clumsy and sluggish in its travelling gait, but quick as thought in its defense. I will here add in conclusion, a circumstance which occurred about ten days since, and was related to me by Mr. H——— of Cumberland, a gentleman of veracity and observation in these subjects. I give his own relation: 'I had driven down to where the road passed a scrub, when immediately in front of the horses, I discovered a huge rattlesnake crossing the road. I dismounted and followed the snake into the bushes, whilst it appeared perfectly regardless of my presence. I wondered at its total disregard of me, and repeatedly touched it with a stick which I had broken for the purpose, but it did neither arrest its progress, or in any way excite its notice. This appeared truly strange in an animal usually so sensitive. Whilst I was endeavoring to get an opportunity to kill it, I discovered the object of pursuit in *a full grown rabbit* within fifteen feet, and immediately in front of the snake. The rabbit appeared to disregard *me*, but with its attention fastened upon the snake, made several springs in an oblique approximation to the snake's course, which also changed its route to that of its victim. These maneuvres occurred sev-

*32. ——? ——? Chatham.

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eral times, the rabbit watching the approaching danger with a seeming drowsy stupidity, until it came within six feet, at which time I made a blow at the snake. It did not rattle until I had injured it severely by repeated blows. After killing it, I found that the rabbit remained in one position near by, until I aroused it by one or two light applications of the stick, when it sprang away in the utmost fright. I much regret that my haste deprived me of the *finale* of all this.'"

I had been informed that Capt. Floyd on casting away the snake was taken with violent vomiting which lasted for six hours, and that every thing appeared green to his sight. I therefore on the receipt of the letter containing the above extracts, wrote him again to ascertain the truth, and he replied that my informant had blended two circumstances, one of which was a Mr. Fitchett having killed a large rattlesnake, to ascertain if it had any strong smell, brought his face in close contact with the belly of the snake, and almost instantly it occasioned violent vomiting, though the snake was dead. "But," Capt. F. adds, "the effect on myself was a faint sickening feeling, produced, I believe, from the idea of having a large and poisonous serpent in my hands, and from perceiving that it gradually and in spite of my utmost pressure increased the distance between its head and my hand, thereby gaining an advantage every instant which would soon enable it to bite my hand. This, and the necessity of casting it away clear, so as to prevent entanglement with any part of it, created a great excitement in me, (for from the moment I seized it, and felt its cold scaly creeping muscles working through my hands, I regretted that I had taken hold of it, and knew that the slightest loss of my presence of mind would endanger me,) and I believe created that sickening, nervous sensation which left me soon after I had thrown away the snake. Objects around did not 'appear green,' neither was 'vomiting occasioned.' Every thing wore the usual aspect—there was not a semblance of optical or other delusion—and the holding of a large live rattlesnake (together with its very disagreeable and suffocating smell) produced the most natural sensations possible upon the nervous system."

*32. Mr. Wm. G. Buell of Chatham, already mentioned, assures me that he has this season taken at Chatham a small snake, the length he imagines about nine or ten inches, with a horny tail, wholly unlike any other snake he has ever seen. He secured him alive, rolled him up in a newspaper and put him under a stone until his return from a short distance whither he was going, but on his return some boys had found him, and by accident or carelessness had lost him. Since that another specimen has been found of the same dimensions and similar tail, but was destroyed by the farmer who found and mashed him to fragments. The latter was said to be a pure or fine *flesh color;* his specimen was different in color but doubtless the same species. I showed Mr. Buell in my cabinet a fine specimen (as yet undescribed) of the *horn and hoop snake* taken in Alabama, (and presented me by Mr. Peabody of Bridgeport,) and Mr. Buell remarked that the *horn part of the tail* resembled that of my specimen, but that the snake in all other respects was wholly unlike. There is therefore unquestionably a new species and probably a new genus of snake in Connecticut, not yet ascertained. It is mentioned with a hope that some individual in that town or towns adjacent may succeed in finding and securing a specimen, and thus at least afford us some further intelligence on the subject, which will be thankfully received. It is believed this list embraces all the snakes we have in this state, two only of which are known to be dangerously poisonous or venomous.

## Order IV. Batrachia.

### Family *Ranidæ.*

*33. Rana pipiens, Linn., Bull Frog, ———, common.

34. Rana fontinalis, Le Conte, Yellow-throated Green Frog, common.

35. Rana halecina, Kalm, Leopard Frog, common.

36. Rana palustris, Le Conte, Pickerel Frog, common.

*37. Rana sylvatica, Le Conte, Wood Frog, common.

*38. Rana horiconensis, Holbrook, Northern Bull Frog, Canaan.

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I have found the popular error quite prevalent, that the venomous snakes are viviparous, while the harmless ones are oviparous. This opinion is of course wholly unfounded, since it is well known that all reptilia are oviparous.

Allow me to add here, while on the subject of eggs, the singular fact that the egg of the *crocodile* of the Eastern continent has a thick heavy shell; while those of the *alligator*, and all those of other reptiles producing eggs in our country, have no shell. I have the egg of a crocodile from Burmah, about the size of that of our common goose, and the shell equally thick and hard.

*33. The bull frog devours its young in great numbers. One I took this season had his stomach greatly distended with the young of his own species, some as large as five or six inches in length, including the tail, and more than an inch in diameter, some of the largest young frogs with tail and legs attached that I ever beheld. They were not masticated, and very nearly perfect. I have since found another whose stomach contained many little shells, such as *Physa*, *Limnea* and *Cyclas*, with their animals partly digested. Frogs will survive a long time however without any apparent sustenance, except what they derive from the water in which they may be confined.

*37. The five preceding species are found plentifully in most of our fresh-water streams and ponds. They all occasionally pass over a great extent of land without water, as they choose to move either for change or amusement. I once knew a farmer, if the weather was hot and his oxen disposed to loll, as is not uncommon when much heated, who would send his plough-boy to the nearest brook to collect frogs, and on his return with them the farmer would open the mouth of an ox, and let one or two live frogs leap down, and it served always to cool the ox in a moment, so that he could immediately resume his ploughing without the danger of overheating the ox. I mention this fact here merely with the hope it may be useful to farmers as a means of preserving their oxen from a surfeit or overheating.

*38. This large frog, I learn from Mr. Munson in North Canaan, was some years since known to inhabit a small locality in that town near the residence of a Mr. Richards, and obtained the name of *Richards' frog*, being much larger and a different color from the bull frog. Back very dark, nearly black, sides green, and belly white. Mr. M. had often seen it, but for several years past it had been extinct. As this place (North Canaan) is not very distant from Lake George, where it was first obtained by Dr. Holbrook, there can be little doubt this frog once inhabited Connecticut. Dr. Dekay remarks that its note is very sonorous and on a lower key than the bull frog. Mr. Munson informed me that the voice is wholly dissimilar to that of our common bull frog. Dr. H. gave the specific name from the Indian name of Lake George—*Horicon.*

*39. Scaphiopus solitarius, Holbrook, Hermit Spade-Foot, Stratford.

*40. Bufo Americanus, Le Conte, American Toad, common.

*41. Hylodes Pickeringi, Holbrook, Pickering's hylodes, Stratford and Northford.

*42. Hyla squirella, Bosc., Little Squirrel Hyla, Massachusetts and New York.

*43. Hyla versicolor, Le Conte, Northern Tree Toad, common.

Family *Salamandridæ.*

*44. Salamandra fasciata, Green, Banded Salamander, common.

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*39. My specimen was found floating at the mouth of the Housatonic by Master D. Giraud and brought to me alive. The moisture or liquid that exuded from its whole surface in twelve hours was almost incredibly great. It appears to correspond with Dr. Dekay's description, page 66 of his Report, but the toes of its hind feet being unlike his figure was a perplexity to me until I saw Dr. Holbrook's figure, which perfectly corresponds with my animal. It has all the peculiar marks of the Scaphiopus. Dr. Dekay asserts that it is found in great numbers at Salem, N. Y., which is near our state line, and it is therefore doubtless a denizen of Connecticut in other parts of this county.

*40. I would here remark respecting our common toad, that a few years since in autumn, when cutting down the tops of my dahlias, before removing the roots to sand for winter quarters, I found a large swell in a stalk near the ground perfectly closed, and without the least apparent orifice; but on cutting it open, out leaped a living toad of ordinary size and perfectly well. The only solution I could make of it was, that some insect must first have punctured the dahlia stalk, and in its rapid growth a small hollow must have been caused, into which the toad while young and small entered, and probably lodged for a day or so, and the rapid growth of the plant held him there until it surrounded him, and accommodated its growth to the incumbrance of the toad inside. But what supported the toad and thus increased his size, is not so plain.

*41. I have two fine specimens of this little lump of animal matter, presented me from Northford by my brother, Mr. John S. Linsley, of that place, where he took them. Mr. Wm. O. Ayres informs me that it has also recently been taken in East Hartford.

The *Hylodes grillus*, (*Cricket hyla,*) has according to Dr. Dekay been taken near New York, but I have not learned of its being yet found in New England, and have therefore omitted its insertion here.

*42. The little peeping hyla, called also squirrel hyla, has been taken in Roxbury, Mass. and near New York, as announced in the interesting Reports of Dr. Storer and Dr. Dekay. Dr. Holbrook however considers it exclusively a southern species, and if so, was probably *introduced* from thence to the northern and eastern states.

*43. The tree toad is found in every town in Connecticut, as far as I am acquainted; and its hoarse guttural cry is always considered an indication of rain, as I have for many years observed.

*44. Of this common species of salamander I have many specimens, no two of which are alike in their bands, but still so near alike as to make it certain they are

*45. Salamandra symmetrica, Harlan, Stratford.

*46. Salamandra erythronota, Green, Red-backed Salamander, common.

*47. Salamandra bilineata, Green, Striped Salamander, Orange.

*48. Salamandra subviolacea, Barton, Violet-colored Salamander, Huntington and Northford.

*49. Salamandra salmonea, Storer, Salmon-colored Salamander, Stonington.

*50. Salamandra millepunctata, Storer, Many-dotted Salamander, Stratford.

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the same species. The whole race of salamanders, as far as I have discovered, are not only perfectly harmless, but exhibit no signs of resistance when taken in the hand, except a great desire to escape.

*45. In many respects there is a great resemblance between the *symmetrica* and the *millepunctata*, though sufficient difference to characterize the species. It is found from Maine to Florida, as appears by different authors.

*46. The red-backed salamander is the most common of any of the species in Connecticut. I find it in nearly every town where I have visited and searched for *Helices* and *Pupas*, under decaying logs and stones. This animal is usually found with the *Helix arborea.*

*47. Of the striped salamander I have taken a specimen in the town of Orange, found under bark with *Helix monodon*, that answers well to Holbrook's description. The tail is more slender and longer in proportion to the whole length of the animal than that of the preceding species. Still I should not be surprised to find it eventually considered only a *variety* of the red-back.

*48. I have taken one specimen of the violet-colored salamander at Huntington, and received another from my brother at Northford, both of which correspond well with Dr. Dekay's and Dr. Holbrook's figures and descriptions as well as size. I have also another specimen seven and a half inches in length from the town of Trumbull, that differs very essentially from the other two. It was sent to me by Dr. E. Middlebrook in alcohol, into which it had been recently placed. It was found in company with several others which were said to be much larger. On this the spots are large, distinct, regular, and nearly parallel through the whole length of the back. I have seen no figure like it in any of the books except Catesby's (of 1772) on "the Natural History of Georgia, Florida, and the Bahama Islands." In that work (p. 110, fig. 2) is represented his "*Stellio aquaticus minor Americanus*," in the bill of a crane that answers very nearly to my animal with some slight differences in number of spots on the tail. His animal, however, was but five inches long—only two thirds the length of mine.

Although Barton's specific name of *venenosa* has the priority for this species, it is so inappropriate, his subsequent name adopted by Dr. Holbrook is preferred.

*49. Of the salmon-colored salamander, Mr. J. H. Trumbull of Stonington has taken a specimen this season, as he informed me by letter.

*50. The many-dotted salamander, erroneously considered by some naturalists the *dorsalis* of Harlan, is not very rare. I took five or six individuals as late in the season as November last, under pieces of timber on the borders of a pond, and sent two to Dr. Storer for the Boston Society of Natural History, and two to Mr. Cozzens, of the New York Lyceum of Natural History. It has also been taken at Ston-

*51. Salamandra picta, Harlan, Painted Salamander, East Hartford.

*52. Salamandra glutinosa, Green, Blue-spotted Salamander, Northford.

*53. Salamandra maculata, Green, Brown-spotted Salamander, Canaan.

*54. Salamandra tigrina, Green, Yellow-spotted Salamander, ?

*55. Salamandra longicauda, Green, Long-tailed Salamander, Salisbury.

Before concluding this article, I wish to remark respecting my "*Catalogue of the Birds of Connecticut*," that the few notes inclosed in brackets and signed "J. D. W.," were added after I had corrected and returned the proof-sheets, and were unknown to me until all the copies had been printed. I mention it here with a view to *explain* the apparent discrepancy in notes 71 and 72 of that list. The latter note had evidently not been noticed by Dr. J. D. W. He added the locality or habitat of "*New Haven*" after Stratford to more than eighty species, which rendered it necessary for the erasure of note 72.

I had added *New Haven* only to the rarer birds, though the Doctor had very kindly and obligingly furnished me with a list of such birds as he had previously found at New Haven, and for which due credit had been given in the introduction to my catalogue.

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ington, or the true *dorsalis*. It was supposed by Mr. Trumbull to be the latter. Mr. Wm. O. Ayres has also taken it (i. e. the *millepunctata*) at East Hartford.

*51. Mr. Ayres informs me this species has been taken at East Hartford.

*52. I obtained a specimen of the blue-spotted salamander at Northford in 1842.

*53. It is said by Dr. Dekay that this is the most common species in our country, and is supposed by Dr. Holbrook to be the *rubra* of Daudin. It is said to be not uncommon in the northwest portion of the state, as I am informed by many persons in that vicinity.

*54. Dr. Holbrook remarks, Vol. III, p. 110, that the *S. tigrina* is found in the northern states from New Jersey to Massachusetts.

*55. Mr. Frederick Plumb of Salisbury, and several other gentlemen in Canaan, Litchfield County, assure me they have found this beautiful and singular species in those towns. I saw a fine specimen in the New York Lyceum, (563 Broadway,) that I believe was taken near Albany.

All the salamanders herein named are not only harmless, and ought therefore not to be destroyed, except for useful preservation, but they consume immense quantities of insects, and ought therefore to be preserved for the good they actually accomplish.

I am happy now to add in regard to the birds of Connecticut, that the "*cliff swallow*," or as I should prefer to call it, *society swallow*, has been a resident of Connecticut for more than twelve years, as I am well informed by observing gentlemen in Litchfield County. I recently passed a great collection of them in Brookfield, where they have been for many years; and Wm. O. Ayres, Esq. also informs me, they have been two or three years in Hartford and its vicinity.

The Golden-winged Warbler (*Sylvia chrysoptera*) I saw last spring in my garden, and Mr. Ayres saw and obtained it in East Hartford, and also six specimens of the lesser *red-poll* out of hundreds seen at the place.

He also obtained a specimen of Cooper's Hawk and the little Corporal Hawk. I have also seen in Stratford the Rough-legged Hawk, (*Falco Sancti-Johannis* of Bonaparte, *F. lagopus* and *niger* of Wilson.)

Elmwood Place, Stratford, Nov. 1, 1843.

Postscript.—I have this day, (Nov. 13,) taken a species of tortoise not enumerated in the preceding list of reptiles, and probably never before found in New England. As it is too late to add this species to the Chelonidæ, (the sheet containing that family having gone to press,) it is inserted in this place.

*56. Kinosternon Pennsylvanicum, Bell, Mud Tortoise, Stratford.

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*56. This is the *Testudo Pennsylvanica*, of Edwards, the *Cistuda Pennsylvanica*, of Say, the *Emys Pennsylvanica*, of Harlan, and the *Kinosternon Pennsylvanicum*, of Holbrook and Dekay. *Shell*, length 4 inches, width 2·6, depth 1·5 inches It is narrower in proportion to its length, than any of our tortoises, except *Sphargis coriacea*. The posterior portion of the shell being almost perpendicularly elevated, constitutes a very distinguishing feature of this animal, and will prevent its being taken for any other species. It is however the most nearly allied to the *Sternothærus odoratus*.

It has been asserted by naturalists, that the common toad casts its skin, and in proof of this fact I would remark that I was informed by the Rev. Mr. Smith of this town, that he once saw the common toad *cast his skin*, in the manner following. He began by scratching holes in the old skin with his hind feet on his sides, and by various movements and evolutions, he succeeded in getting the end of this skin into his mouth, and then by swelling like a bladder and at the same time pulling with his mouth and repeating the operation, alternately swelling and falling, he succeeded in pulling the whole into his mouth, and swallowing it. The appearance of the toad was thus changed from a filthy to a bright and shining animal. This operation is not new, but may serve to establish what to those who have not witnessed it, might appear doubtful. J. H. L.

Art. V.—*Remarks on the Theory of Compound Salt Radicals;* by Wolcott Gibbs.

1. In a memoir appended to the last edition of his Compendium of Chemistry, and republished in this Journal, Vol. xlv, pp. 52, 247, Dr. Hare has brought forward a number of powerful arguments against the doctrine of compound salt-radicals, which has recently made great progress among European chemists, and at present threatens to subvert all established theories and nomenclature, and to erect the superstructure of chemical science upon a foundation apparently far too unsubstantial to support its gigantic proportions and rapidly increasing weight. This theory sets out from a principle very different from any which chemists have been hitherto accustomed to admit, and which would seem to be involved in a philosophical idea of the province and objects of chemistry, since it aims at explaining a few superficial resemblances in purely *physical* properties, by making a total change in the *chemical* constitution of those substances between which such resemblances exist, as well as of innumerable others which display in their physical relations far more striking discordances. Thus the physical similarity between the chlorides, iodides, &c. of the alkaline and earthy metals, and the sulphates, nitrates and other oxysalts of the same metallic radicals, is made the basis of a total change in our views of the chemical constitution of all salts whatever, while the much more remarkable and more widely extended differences between other members of the same classes of compounds, so forcibly urged and so clearly illustrated by Dr. Hare, are left entirely unnoticed or swallowed up in the sweeping assertion that the salts of the simple haloid type, and the salts composed of amphacids and amphibases, form "a series of basic and acid compounds for the most part completely parallel."

2. The principal arguments which have been brought forward in favor of the salt-radical theory, which is in part based upon this assumed parallelism, have been ably discussed by Dr. Hare in the memoir above alluded to. In the present paper I propose to offer a few remarks upon some points to which the attention of chemists does not appear to have been particularly directed. For the sake of brevity I shall employ the terms *amphide* and *halide* to designate respectively the compounds of the amphigen and halogen bodies of Berzelius with electro-positive radicals,

while the term *ide*, from the terminal syllable of the words oxide, chloride, &c. will serve to embrace in a single group all amphides and halides whatever, whether acids or bases.

3. In the first place then it is remarkable, that while it is asserted in favor of the new theory, that a great number of what are termed oxyacids have *not* been obtained in an isolated state or uncombined with bases, the fact that the oxysalts themselves constitute but one out of four very numerous classes of salts, viz. sulphur-salts, selenio-salts and telluri-salts, and that without exception the sulph-acids, selen-acids and tellur-acids *have* been obtained uncombined with bases, is wholly neglected. Indeed the supporters of the new theory do not appear to have at all contemplated the effects of its extension beyond the comparatively narrow limits of the oxysalts, considered as forming a single family.

4. In the case of almost all those oxysalts in which the existence of an electro-negative oxyacid has not been demonstrated synthetically, a definite isolated amphide or halide exists, whose formula is precisely analogous to that which the hypothetic oxyacid would have if obtained in a separate state. Thus the existence of acetic, formic, benzoic and oxalic acids in the salts whose formulas are $AcO_3+RO$, $FoO_3+RO$, $BzO+RO$, $C_2O_3+RO$, may be inferred from the well known possibility of obtaining in an isolated state the chlorides, iodides, sulphides, &c. $AcCl_3$, $FoCl_3$, $FoI_3$, $BzCl$, $BzS$, $BzI$, $C_2Cl_3$, which obviously correspond to the hypothetic $AcO_3$, $FoO_3$, $BzO$, $C_2O_3$.

5. In the particular cases of nitric, chloric and bromic acids, no such parallel amphides or halides are known to exist, yet the argument from analogy is even in these cases hardly less strong. The isolable oxides of antimony $SbO_3$, $SbO_4$, $SbO_5$ are completely parallel to those of nitrogen $NO_3$, $NO_4$, $NO_5$, of which the first two may also be obtained in a separate state; and in like manner the existence of such compounds as $ClO_5$, and $BzO_5$, is rendered, to say the least, extremely probable, by that of the definite corresponding iodic acid, $IO_5$, whose compounds with oxybases so strongly resemble the chlorates and bromates.

6. In addition to the very forcible observation of Dr. Hare, that while *some* of the oxygen acids have not been isolated, *all* of the assumed salt-radicals are in the same predicament, it may be worth while to state that the assertion of Dr. Kane, that, of all known acids, those which have not hitherto been obtained uncombined with bases constitute a great majority, would be

very much too broad, even were it asserted of the oxyacids alone. These, as already observed, consitute, even upon the ordinary view, about one fourth of the whole number of those usually admitted by chemists. Whereas agreeably to the views of Bonsdorff, Hare and Thomson, in accordance with which, what are termed double chlorides, double iodides, &c. are really simple salts of halogen acids and bases, the oxysalts do not constitute the eighth part of the whole number of salts at present known and described. While if those saline substances, the electro-negative ingredients of whose acids and bases are compound radicals like cyanogen, amidogen, or mellon, are taken into the computation, the number of the oxysalts becomes comparatively very small.

7. In the next place, while it is asserted that the hypothetical salt-radicals by combining with electro-positive substances form compounds exactly analogous in constitution to simple chlorides, iodides, &c., it has not been observed that if they indeed do so, they become precisely as similar to oxides and sulphides as to chlorides and halides generally. Since, till the new theory of salts began to occupy a prominent place in theoretical chemistry, the existence of a halide of any particular atomic constitution or type was deemed *a priori* almost a demonstration of the existence of amphides of the same type, and *vice versa*. So that if a protochloride and a sesquichloride of a new metallic radical were to be discovered, it might thence be immediately and certainly inferred that there were oxides, sulphides, selenides and tellurides, as well as iodides, bromides and fluorides of an exactly analogous composition. If therefore the formulæ, $M+SO_4$, $M+2SO_4$, $M_2+SO_4$, $M_2+3SO_4$, adduced by Prof. Graham, from their obvious analogy to those of simple chlorides, $M+Cl$, $M+2Cl$, $M_2+Cl$, $M_2+3Cl$, be considered as demonstrating the general molecular resemblance of the salts containing compound salt-radicals to the simple halides, they must also demonstrate their analogy to the oxides and sulphides whose formulæ are precisely similar, $M+O$, $M+2O$, $M_2+O$, $M_2+3O$, $M+S$, $M+2S$, $M_2+S$, $M_2+3S$.

8. The analogy between the compound electro-negative *ions* assumed in the new theory, to the simple halogen bodies, will be found upon close examination to be extremely superficial. If for instance the monobasic, bibasic and tribasic oxyphosphions $PO_6$, $PO_7$, $PO_8$, are analogous to chlorine, why should they be inca-

pable of combining in more than one proportion? Why have we not such compounds as $M+2PO_6$, $M+3PO_6$, $M+5PO_6$, $2M+7PO_6$, $2M+5PO_7$, $2M+7PO_7$, $3M+3PO_8$, $3M+5PO_8$, corresponding to $M+2Cl$, $M+3Cl$, $M+5Cl$, $M_2+7Cl$, $M_2+7F$? The instances of such agreement brought forward by Graham in regard to the oxysulphion $SO_4$, and cited in the last paragraph, go but a very little way toward establishing the complete parallelism asserted to exist between the two classes of compounds. No attempt is made by either Graham or Kane to carry out this assumption in the case of the bibasic and tribasic salt-radicals.

9. No simple substance whatever, whether amphigen or halogen, can be said to be either monobasic, bibasic, or tribasic. An amphigen or halogen body combines with but one or at most two equivalents of an electro-positive radical or basyle, and there is no such thing as assigning a *fixed* number of electro-positive atoms to any of the simple electro-negative ions.

10. It seems to have escaped notice that the phosphorous acid is tribasic as well as the phosphoric. This being the case, the formula of a phosphite $PO_3+3MO$ becomes on the new view $PO_6+3M$. But that of a monobasic phosphate is also, on the same view, $PO_6+M$. Consequently the oxyphosphion $PO_6$ is both monobasic and tribasic; is not this at least as incomprehensible as that phosphoric acid should by some change in its molecular structure, perhaps by the doubling or trebling of its atomic weight, become capable of combining with one, two, or three atoms of base? Recourse must either be had to the doctrine of isomerism, and it must be considered that there are two oxyphosphions each of which has the formula $PO_6$ but of which one is monobasic and the other tribasic, or else the very same difficulty presents itself upon the new view which was formerly urged against the old. But it should be remembered that if such an explanation be admitted in the case of the salt-radical $PO_6$, it must be equally good in the case of the acid $PO_5$, and we may assume that there are three isomeric phosphoric acids respectively capable of combining with one, two, or three atoms of base.

12. The admirable researches of Graham on the constitution of salts, have demonstrated that one oxysalt enters into combination with another only by a replacement of its constitutional water. Thus the double sulphate of zinc and potassa $(ZnO,SO_3+KO,SO_3)+6Aq$ is formed from common sulphate of zinc, $(ZnO,SO_3+HO)+6Aq$ by the substitution of an atom of

sulphate of potash for an atom of water, the double sulphate of magnesia and potassa ($MgO,SO_3+KO,SO_3$)+6Aq, and innumerable other double salts by a precisely similar replacement, the crystallogenic water remaining constant. Hence it clearly appears that there exists between an oxysalt and an oxide of the magnesian family, an analogy so strong that they are capable of replacing one another in a third substance without altering its molecular type. If then there exists between a double oxysalt and a double chloride that perfect analogy which is asserted by the supporters of the new theory, it follows that one of the two chlorides enters into combination with the other only by replacing its water of constitution. Yet a careful comparison of the formulæ of the simple and double chlorides clearly shows that such is not the case. Even if it were so, it would only exhibit another argument against the salt-radical theory, since obviously it would then demonstrate that analogy between a simple chloride, as HCl, and a simple oxide, as HO, which is so obstinately denied by the advocates of the new view.

12. It appears to be a general law in chemistry, that the more simple the chemical constitution of a body, the more simple is its crystalline form. Thus simple substances, with but few exceptions, crystallize in the regular system. Anhydrous protohalides, as protochlorides, protocyanides, &c. almost universally appear crystallized in cubes or regular octahedrons. Anhydrous protoamphides in like manner, so far as our knowledge of them extends, assume the same forms; the protosulphides of lead, zinc, and silver, will serve as examples. On the other hand, when the simple molecule of metal assumes more than one atom of amphigen or halogen body, or when the protohalide or protoamphide combines with crystallogenic or constitutional water, it assumes a more complicated crystalline form and structure. Agreeably to this law the compounds of salt-radicals with metallic basyles should, when anhydrous, appear crystallized in the regular system, whereas on the contrary a close examination shows that this is very rarely the case. It appears then that the supposed resemblance between the two classes of salts, viz. the haloid salts and the salts of amphacids and amphibases, fails in a most material and striking manner when they are compared by the only exact standard of physical similarity which we possess—identity of crystalline form.

New York, October 23d, 1843.

ART. VI.—*An Abstract (from Kane's Elements,) of the Arguments in favor of the Existence of Compound Radicals in Amphide Salts.*

HAVING published Dr. Hare's *effort to refute the arguments advanced in favor of the existence of compound radicals in amphide salts*, it may be just, as respects those readers who have not access to Kane's Elements, to republish from that work the arguments in question. (See page 631.)

"It had been long remarked as curious, that bodies so totally different in composition as the compound of chlorine with a metal on the hand, and of an oxygen acid with the oxide of the metal on the other, should be so similar in properties, that both must be classed together as *salts*, and should give origin to series of basic and acid compounds for the most part completely parallel. This difficulty has been so much felt by the most enlightened chemists, that doubts have been raised as to whether the acid and base, which are placed in contact to form by their union an oxygen salt, really exist in it when formed; and it has been suggested, that at the moment of union a new arrangement of elements takes place, by which the structure of the resulting salt is assimilated to that of a compound of chlorine or of iodine with a metal. This view, at first sight so far-fetched, which considers that in glauber's salt there is neither sulphuric acid, nor soda, but sulphur, oxygen, and sodium, in some other and simpler mode of combination, is now very extensively received by chemists; and I shall proceed, therefore, to describe with some detail the form which it has assumed, and the evidence by which it is supported.

"The greater number of those bodies which are termed oxygen acids, have not been in reality insulated, and what are popularly so called are merely supposed to contain the dry acid combined with water. Thus the nearest approach we can make to nitric acid, is the liquid $NO^6H$; to acetic acid, the crystalline body $C^4H^4O^4$; and to oxalic acid, the sublimed crystals $C^2O^4H$; we look upon these bodies as being combinations of the *dry acid* with water, and we write their formulæ $NO^5+HO$, and $C^4H^3O^3+HO$ and $C^2O^3+HO$, but that these dry acids exist at all is a mere assumption. Hence with regard to these instances, and they embrace the majority of all known acids, the idea that the acid and base really exist in the salt formed by the action of hydrated acids on a base, is purely theoretical.

"When we compare the constitution of a neutral salt with that of the hydrated acid by which it is formed, we find the positive result to be the substitution of a metal for the hydrogen of the latter, thus, $SO^3+HO$ gives with zinc $SO^3+ZnO$; and where a metal is acted on by an hydrated acid, the hydrogen is thus evolved either directly as gas, or it reacts on the elements of the acid and gives rise to secondary products which are evolved, such as sulphurous acid, nitric oxide, &c. In all cases we may consider the action of a metal on a hydrated acid, to be primarily the elimination of hydrogen and the formation of a neutral salt. But in this respect the action becomes completely analogous to that of the metal on a hydracid, except that in the latter case a haloid salt is formed, and hence we assimilate the two classes in constitution by a very simple arrangement of their formulæ.

"There are, however, a number of acids which may be obtained in a dry and isolated form, as the sulphuric, the silicic, the telluric, the stannic, the arsenic, the phosphoric, &c., and when they combine with bases, it is most natural to consider the union as being direct, and that the salt contains acid and base really as such. This is accordingly the strongest point of the ordinary theory. But other and important circumstances intervene. These acids, although they may be obtained free from water, yet in that state they combine with bases but very feebly, and require a high temperature in order to bring their affinities into play. On the other hand, in all cases where these bodies manifest their acid characters in the highest degree, they are combined with water, as in oil of vitriol and phosphoric acid, and when expelled from combination with a base, they immediately enter into combination with water in an equivalent proportion. Thus where phosphate of lime is decomposed by oil of vitriol, it is not phosphoric acid ($PO^5$) which is found in the liquor, but its terhydrate ($PO^5+3HO$), as is shown by its forming with oxide of silver the yellow phosphate $PO^5+3AgO$. In the case of telluric acid, its hydrate ($TeO^3+3HO$) is very soluble in water, it crystallizes in large prisms; by 212° two atoms of water are given off, but its nature is not changed, the body which remains ($TeO^3+HO$) is still acid and soluble in water, perfectly neutralizing the alkalies; but by a red heat this last atom of water is driven off, and then the whole nature of the body changes, it is insoluble in water, and even in the strongest alkaline solutions, and can only be brought back to its former state by being fused with potash at a red heat. Here it is evident that the acid properties and the water go together; and we may conclude, that in order to manifest strong acid properties, the acid must be in its hydrated form. But in that hydrated form, if the water acted as a base simply, the tendency of the acid to combine with other bases should be inferior to that of the dry acid; for if we place oil of vitriol and barytes together, the water must be first expelled before the barytes and sulphuric acid can unite, and hence an impediment would exist to their union which should not occur with cold barytes and dry sulphuric acid in vapor, and yet cold barytes and oil of vitriol will combine with such intensity as to produce ignition, whilst the barytes must be heated before it begins to combine with the dry sulphuric acid. The water, therefore, is essential to the manifestation of strong acid properties, and it does not exist in combination with the acid merely as a base. What, then, is the constitution of a hydrated oxygen acid?

"When muriatic acid (HCl) acts on zinc, the metal is taken up, forming ZnCl, and hydrogen is expelled, and if, in place of zinc, oxide of zinc be taken, the effect is the same, except that the hydrogen combining with the oxygen of the oxide forms water; HCl and ZnO giving ZnCl and HO. Now we have in oil of vitriol the elements $SO^4H$ combined together; when put in contact with zinc, H is expelled, and $SO^4Zn$ is formed, and with ZnO and $SO^4H$, there are produced $SO^4Zn$, and HO is set free. In both cases, of which the former may be taken as the type of all the haloid salts, and the latter of all salts formed by oxygen acids, there is H as the element which is removable by a metal, precisely as one metal is replaceable by another, as indeed from the real metallic character of hydrogen may be considered to occur in this case. Every acid may, therefore, be considered to consist of hydrogen combined with an electro-negative element, which may be *simple*, as chlorine, iodine, fluorine; or may be compound, as cyanogen, $NC^2$, and yet capable of being isolated; or as occurs in the great majority of cases, its elements may be such as can only remain together when in combination. Thus oil of vitriol does not contain $SO^3$ and HO, but consists of hydrogen united to a compound radical $SO^4$. Liquid nitric acid does not contain $NO^5$ and HO, but consists of hydrogen united to a compound radical $NO^6$, and the acetic acid is written $C^4H^3O^4+H$, the oxalic acid $C^2O^4+H$, and so on.

"The elegance and simplicity with which the laws of saline combination may be deduced from these principles is really remarkable. Thus it has been remarked as a fact substantiated by experiment, that in neutral salts the number of equivalents of acid were proportional to the number of equivalents of oxygen in the base, but the ordinary theory gave no indication of why this should occur. It follows necessarily from the principles of the newer theory. Thus, if a protoxide be acted on by an acid, M denoting the metal of the oxide, and R the radical of the acid, the resulting action is

$$M+O \text{ and } H+R, \text{ produce } H+O \text{ and } M+R,$$

and in the neutral salt there is an equivalent of each. Now in the case of a sesquioxide, in order that water shall be formed, and so neither acid nor base in excess, the reaction is that

$$M^2+O^3 \text{ and } 3(H+R), \text{ produce } 3(H+O) \text{ and } M^2+R^3,$$

a sesqui-compound being formed perfectly analogous to a sesquioxide, and the number of atoms of acid, $3(H+R)$, is equal to the number of atoms of oxygen in the base ($M^2O^3$), because that number of atoms of hydrogen are required for the decomposition of the base. In like manner for a deutoxide, there is

$$M+O^2 \text{ and } 2(H+R), \text{ producing } 2(HO) \text{ and } M+R^2.$$

The power of salts to replace water in the magnesian sulphates, so as to form double salts, becomes much more intelligible when we compare $H+O$ with $K+SO^4$, than where HO was contrasted with the complex formula $KO+SO^3$.

"The circumstance that on the new theory (or as it is now often called, the *binary theory of salts*,) it is necessary to admit the existence of a great number of bodies (these *salt radicals*) which have never been isolated, and in favor of whose existence there is no other proof than their utility in supporting this view, becomes more powerful as an objection, when we proceed to apply its principles to the salts of phosphoric acid. For it has been already described, that this acid forms three distinct classes of salts, all neutral, and which have their origin in the three hydrated states of the phosphoric acid. These states are written on the two views as follows:—

| | Old theory. | New theory. |
|---|---|---|
| Monobasic acid, | $PO^5+HO$ | $PO^6+H$ |
| Bibasic acid, | $PO^5+2HO$ | $PO^7+H^2$ |
| Tribasic acid, | $PO^5+3HO$ | $PO^8+H^3$ |

"Now it appears very useless, where the older view accounts so simply for the properties and constitutions of these salts, to adopt so violent an idea, as that there are three distinct compounds of phosphorus and òxygen which no chemist has ever been able to detect. But here again other circumstances must be studied; first, the difference of properties of phosphoric acid, in its three states, is totally inexplicable, on the idea of their being merely three degrees of hydration. Nitric acid forms three hydrates, but when neutralized by potash, it always gives the same salt-petre; sulphuric acid forms two perfectly definite hydrates, but with soda forms always the same glauber's salt; whilst phosphoric acid, when neutralized by soda, gives a different kind of salt according to the state it may be in. Also, the permanence of these conditions of phosphoric acid is a powerful proof that they do not consist in the adhesion of mere water. The idea that the phosphoric acid is a different hydracid in each of its three conditions, on the other hand, not merely explains the fact of these differences of properties, but it renders the formation of bibasic and tribasic salts, which is such an anomaly on the old theory, a necessary consequence of the new, for the phosphoric salt radicals, $PO^6$, $PO^7$, and $PO^8$, differ not merely in the quantity of oxygen they contain, but are combined with different quantities of hydrogen, and hence in acting on metallic oxides (bases), there is a different number of atoms required for each to replace the hydrogen and form water. Thus—

$PO^6.H$ and NaO give HO and $PO^6.Na$. monobasic phos. of soda,
$PO^7.H^2$ and 2NaO give 2HO and $PO^7.Na^2$. bibasic phosphate,
$PO^8.H^3$ and 3NaO give 3HO and $PO^8.Na^3$. tribasic phosphate.

A circumstance which gives additional reason to infer that the water is not merely as base in the phosphoric acid, is the following: if it were so, then it should be most completely expelled by the strongest bases, and the bibasic and tribasic phosphates of the alkalies should be those least likely to retain any portion of the basic water; but the reverse is the fact; whilst oxide of silver, a very weak base, is that which most easily and totally replaces the water. On the idea, however, of hydracids, this is easily understood, for the oxide of silver is one most easily reduced by hydrogen, and consequently one on which the action of a hydrogen acid, as $PO^3+H^3$, or $PO^7+H^2$, would be most completely exercised.

"A remarkable verification of this theory has been recently found in the decomposition of solutions of the oxysalts in water, by voltaic electricity. It has been already explained (pp. 314 *et seq.*) that it requires the same quantity of electricity to decompose an equivalent of any binary compound, such as iodide of lead, chloride of silver, muriatic acid, or water. Now, if we dissolve sulphate of soda in water, and pass a current of voltaic electricity through that solution, we have water decomposed, and also the glauber's salt; oxygen and sulphuric acid being evolved at one pole, and soda and hydrogen at the other. Here, on the old view, the electricity performs two decomposing actions at the same time, and, as it thus divides itself, its action on each must be lessened, and the quantity of each decomposed be diminished, so that the sum should represent the proper energy of the current. On measuring these quantities, however, the result is totally different, the quantity of sulphate of soda decomposed is found to be equal to the full duty of the current, and an equivalent of water appears to be decomposed in addition. It is quite unphilosophic to imagine, that the strength of a current should be thus suddenly doubled, and a simple and sufficient explanation of it is found in the new theory of salts. The sulphate of soda in solution having the formula $NaSO^4$ is resolved by the current into its elements, Na and $SO^4$, as chloride of sodium would also be; the sodium, on emerging at the negative electrode, from the influence of the current, instantly decomposes water, and soda and hydrogen, of each an equivalent, are evolved; at the positive electrode the compound radical $So^4$ also decomposes water, and produces $H.SO^4$ and O. The appearance of the oxygen and hydrogen is thus but secondary, and the body really decomposed by the current is only Na $So^4$.

"In the case of the salts of such metals as do not decompose water, the phenomena are much more simple. Thus a solution of sulphate of copper, when decomposed by the battery, yields metallic copper at the negative, and sulphuric acid and oxygen at the positive electrode, and the quantity of copper separated represents exactly the energy of the current which has passed, for the salt being Cu.$SO^4$, is simply resolved into its elements, but $SO^4$ reacting on the water, produces H.$SO^4$ and O at the positive electrode. On the old view, it was supposed that water and sulphate of copper were both decomposed, oxygen and acid being evolved at one side, and oxide of copper and hydrogen being separated at the other; which reacting produced water and the metal. Such an explanation, however, is directly opposed to the law of the definite action of electricity, and cannot be received.

"In the case of solutions of chlorides or iodides, where there can be no doubt of the relations of the elements, the results of voltaic decomposition are precisely similar. Chloride of copper gives simply chlorine and copper, no water being decomposed. Chloride of sodium or iodide of potassium give chlorine or iodine at the one electrode, and alkali and hydrogen at the other; the evolution of these last being caused by the action of the metallic basis on the water of the solution.

"Professor Daniell, to whom these important electro-chemical researches are due, considers the truth of the binary theory of salts to be fully established by them.

"If this theory be adopted, a profound change in our nomenclature of salts will become necessary. Graham has proposed that the name of the salt radical should be formed by prefixing to the word *oxygen* the first word of the ordinary name of the class of salts, and that the salts be termed by changing *oxygen* into *oxides*. Thus $SO^4$ *sulphatoxygen*, gives sulphatoxides, the sulphates. $NO^6$ nitratoxygen, gives nitratoxides, the nitrates, and so on; but I consider that the form of nomenclature proposed by Daniell deserves the preference. It has been described (p. 314) that Faraday proposed to term the elements which pass to the electrodes of the battery, *ions;* acting on this, Daniell proposes to term the electro-negative element of the sulphates *oxysulphion*, that of the nitrates *oxynitrion*, and so on, and the salts may be termed oxysulphion of copper, oxynitrion of sodium, &c. It would be desirable, however, for a long time, to introduce these names only where theoretical considerations rendered their employment decidedly useful, and hence, in all future description of the salts, I shall make use of the language of our ordinary views, and treat of their preparation and composition without any reference to the discussion in which we have been engaged.

"The general adoption of the binary theory of salts has deprived of much of its interest and importance a question, which some years since was very ingeniously discussed, viz.—whether, in the formation of double salts, the salts which unite had the same relation to each other that acid and base were then thought to have. Thus it was supposed that the electro-negative qualities of sulphuric acid being less controlled by oxide of copper than by potash, the alkaline sulphate acted as a base to the sulphate of copper, when these two salts combined to form the double sulphate of potash and copper, and so on in other instances; but in addition to the circumstance that all we have said as to the constitution of the salts militates against this view, we have the positive evidence that, first, these double salts are formed not by combination merely, but by replacement of the constitutional water of the sulphates of the copper or magnesian class, which water nobody would contend to act in them as a base; and second, that when a solution of such a double salt is decomposed by the battery, the two salts are not separated as if they were acid and base, but are decomposed independently in the proportions of an equivalent of each, making together the sum of the chemical energy of the current.

"A similar idea was advocated by Bonsdorff regarding the double chlorides, iodides, &c. He proposed to consider the chlorides of gold, platina, mercury, &c. as chlorine acids, and those of potassium, &c. as chlorine bases, and so with the iodides. This view, however, although at first very extensively adopted, has given way to the gradual growth of knowledge. There is no analogy between a dry oxygen acid and a chloride; but the chlorides are in perfect analogy with the neutral salts. Thus CuCl does not resemble $SO^3$, but $Cu.SO^4$ and $CuCl+KCl$ is analogous not to $SO^3.KO$, but to the double salt $Cu.SO^4+K.SO^4$. Bonsdorff's idea was exactly counter to the direction of truth; he sought to bring all salts under the one head, by extending to all the constitution of oxygen acids and oxygen bases, whilst the progress of science has led us to the opposite generalization of reducing all salts to the simple haloid type."

## *Respecting the Isomeric Acids of Phosphorus.*

A very important modification has been made with respect to the three isomeric states of phosphoric acid. They are inferred to differ from each other *only* in the proportions of water, or other base which they require severally for their saturation; so that there is a monobasic, a bibasic, and tribasic phosphoric acid. When in the state heretofore designated as *free*, they are considered as constituting three phosphates of water. This assumed constitution of these isomeric acids has been represented by Dr. Kane, and other respectable chemists, as affording strong evidence of the existence of compound radicals in certain salts. Dr. Hare has in arguing against the existence of such radicals, adverted to the constitution of the different phosphates of water.* Hence it is deemed expedient to give, in the language of Dr. Kane† an account of the acids of phosphorus to which reference is made, and of their habitudes with basic water and other bases.

"The phosphoric acid has a great affinity for water, combining with it almost explosively. It may form three distinct compounds, *phosphates of water*, the constitution of which is as follows:—

| | | |
|---|---|---|
| Monobasic phosphate of water, | - - | $PO^5+HO$. |
| Bibasic phosphate of water, | - - | $PO^5+2HO$. |
| Tribasic phosphate of water, | - - | $PO^5+3HO$. |

"This relation was first established by the researches of Graham. Phosphoric acid combines not only with water in these three proportions, but each of them is a type of a series of salts, which the phosphoric acid is capable of forming. Thus there is a class of *monobasic phosphates*, another class of *bibasic phosphates*, and a third, which is the most common, of *tribasic phosphates;* the water contained in the phosphates of water being replaced to a greater or less extent, by means of equivalent proportions of ammonia or metallic oxides.

"A solution of phosphoric acid in water, may contain any one of the three phosphates of water that have been described, and when neutralized by bases may hence produce totally different salts. The properties of a solution of phosphoric acid may, therefore, be totally different according to the manner in which it had been prepared, and hence this acid was at one time ranked as a remarkable instance of isomerism; but Graham has beautifully shown, that the difference of properties is only the result of the

* See Effort to refute the arguments in favor of the existence in amphide salts of a compound radical like cyanogen.

† Elements, page 485.

existence of the different states of combination in which the phosphoric acid actually exists. It will consequently be necessary to study separately the properties of the three compounds of phosphoric acid with water.

"*Monobasic phosphate of water.*—A solution of this body reacts powerfully acid, it precipitates albumen (white of egg) in white curds; when neutralized by a base, it gives salts which contain but one atom of base, their formula being $PO^5+RO$; and a soluble salt of it produces in solutions of silver, a white, soft precipitate, $PO^5+AgO$. This is the least stable of the phosphates of water, it gradually passes into the other forms, particularly when its solution is boiled.

"*Bibasic phosphate of water.*—This form of the acid may be prepared by decomposing bibasic phosphate of lead by sulphuretted hydrogen. It is characterized by combining always with two equivalents of base, forming salts, whose formula is $PO^5+2RO$; its salts give, with nitrate of silver, a white precipitate $PO^5+2AgO$, which is not pasty like the monobasic phosphate. The salts of this acid may contain only one equivalent of fixed base, the other being water, and may hence at first sight appear to be constituted like the monobasic salts; the basic water is, however, easily known to be present, by its not being expelled by a moderate heat, with the water of crystallization, but requiring a temperature approaching to ignition for its expulsion.

"*Tribasic phosphate of water.*—This is the form of phosphoric acid which represents the class of salts most generally known; it is characterized by not precipitating albumen, and by combining with three equivalents of base when fully neutralized. In the majority of cases of the three equivalents of base, one is water; thus the common phosphate of soda is a tribasic phosphate, its formula being $(PO^5+2NaO.HO)+24Aq$; when moderately heated, or even by long exposure to dry air, it loses the 24Aq, but it requires to be melted at a red heat, in order to drive off the twenty fifth atom of water; and if this be done, on redissolving the fused mass in water, it crystallizes in a totally different form, and is found to have been changed into bibasic phosphate of soda, the formula of which is $(PO^5+2NaO)+10Aq$. The difference is remarkably shown by the action of these salts on a solution of silver; common phosphate of soda precipitates nitrate of silver of a canary yellow, and the solution becomes acid; one equivalent of tribasic phosphate of soda, decomposing three equivalents of nitrate of silver, producing one equivalent of tribasic phosphate of silver, two of nitrate of soda, and one of nitrate of water; this last being liquid nitric acid, of course renders the liquor acid. The reaction may be simply expressed

$$PO^5+2NaO.HO \text{ and } 3(NO^5+AgO)$$
$$\text{give } PO^5+3AgO \ldots 2(NO^5+NaO) \text{ and } NO^5+HO.$$

If on the other hand, bibasic phosphate of soda be used, the liquor remains neutral, for $PO^5+2NaO$ and $2(NO^5+AgO)$ give $PO^5+2AgO$ and $2(NO^5+NaO)$.

"In the tribasic phosphates, it frequently occurs, that there shall be but one equivalent of fixed base, the other two being water; such salts have frequently an acid reaction, and were formerly called biphosphates. Thus one tribasic phosphate of soda is $PO^5+NaO.2HO$; the biphosphate of ammonia is tribasic, its formula being $PO^5+NH^4O.2HO$.

"These salts of phosphoric acid were originally designated by Graham, metaphosphates, pyrophosphates, and common phosphates."

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Art. VII.—*On the Volume of the Niagara River, as deduced from measurements made in* 1841 *by Mr. E. R. Blackwell, and calculated by* Z. Allen.

Very little attention appears to have been hitherto bestowed on the investigation of the comparative volumes of water discharged by the great rivers of the globe. The relative amount of the evaporation and drainage from the soils of different countries in proportion to the quantity of rain that falls upon each, as denoted by rain-gauges, is also another interesting subject connected with the preceding one; for by measuring the quantity of water discharged from a region of country by the streams that drain it, and by deducting this quantity from the whole amount that falls upon it as indicated by rain-gauges, the relative amount of evaporation may be ascertained. The investigation of these facts forms the basis of a branch of the science of hydrography, and leads to many useful as well as curious and interesting enquiries.

Whilst passing a few days at the Falls of Niagara, in the summer of 1841, it occurred to me to make the necessary admeasurements for ascertaining the quantity of water precipitated by the grand cataract, and drained from the vast area of country bordering on the great lakes of North America. This subject has long remained a matter of mere conjecture, although unusual facilities are offered for making the admeasurement of the volume of this majestic river, from the circumstance of its issuing from Lake Erie in an average equalized current throughout the various seasons of the year, unaffected by the droughts of summer and the floods of winter. In order to ascertain the average volume of water discharged by most other rivers of the earth, it becomes necessary to multiply a great number of observations during the several seasons of the year. But the flow of the Niagara River remains always nearly the same, varying only from the action of the winds on the surface of Lake Erie, and from a periodical succession of several rainy or dry years in the broad regions of the upper lakes.*

The results of the admeasurements of the volume of water of Niagara River, are now submitted, with the hope that they may furnish facts in this branch of the science of hydrography, which will be used as data by scientific men for various calculations;

* It appears from the best information I was enabled to obtain, that a strong breeze or gale on Lake Erie, in the direction of the outlet of this lake, will cause the waters to become heaped up at that end, so as to produce a rise of the level of about two feet; and a corresponding rise of the Niagara River. A subsidence of the level of the surface to an equal extent occurs, whenever a gale takes place in an opposite direction, making a total variation of about four feet in the rise and fall of the level of the river, from the simple action of the wind on the surface of the lake. These changes of level have sometimes taken place in the course of a few hours. A nearly equal, but more gradual change of level, is produced, as before stated, by the alternations of a period of several rainy years followed by a period of successive years of comparative drought.

The descent of the waters of Niagara River, from the outlet of Lake Erie, is at first so considerable, as to cause the flow of the current to become accelerated to a velocity of about eight miles per hour. By means of an embankment constructed parallel with the shore along the margin of the river, the level of the surface of Lake Erie is maintained, or upheld, throughout a distance of several miles, above the level of the descending stream. This embankment serves to form a portion of the Erie Canal, and also to convey a supply of water to several large flour-mills at Black Rock, thus affording an efficient fall of about five feet.

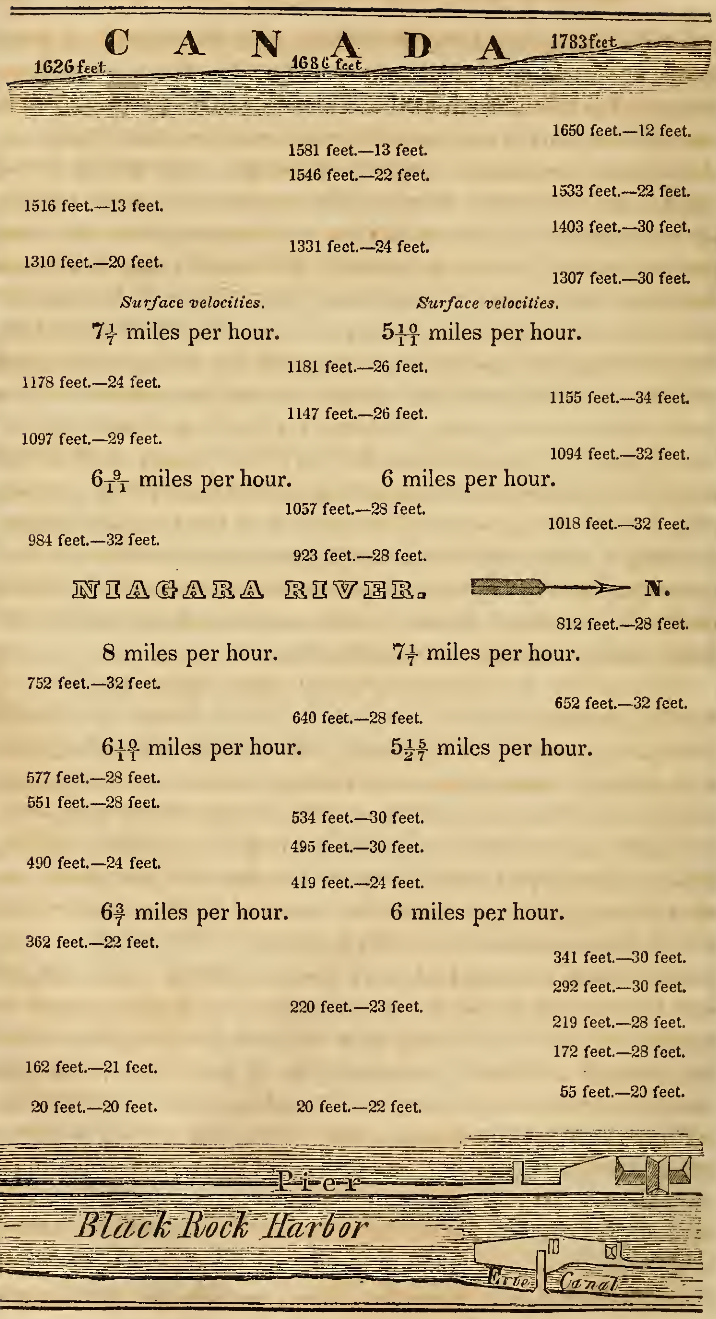
From the general levelness of the low banks of the river between Black Rock and Lewiston, it appears probable that water power to any extent that ever will be required, may be obtained by diverting the water of the Niagara River over the table land adjacent to its bed; and that mills might there be erected sufficient to grind all the wheat produced on the broad regions of country, whose tributary waters swell the great lakes and the Niagara, affording unrivalled facilities for transporting the wheat to these mills.

and with the hope, also, that others may be induced to commence a system of similar admeasurements of the other great rivers of the earth, such as the Mississippi, Ganges, &c., which may form a basis of comparison of their relative magnitudes.

I have also subjoined some calculations, from which it will appear, that the motive power of the cataract of Niagara exceeds by nearly forty fold, all the mechanical force of water and steam power, rendered available in Great Britain, for the purpose of imparting motion to the machinery that suffices to perform the manufacturing labors for a large portion of the inhabitants of the world, including also the power applied for transporting these products by steam boats and steam cars, and their steam ships of war to the remotest seas. Indeed it appears probable that the law of gravity, as established by the Creator, puts forth in this single waterfall more intense and effective energy, than is necessary to move all the artificial machinery of the habitable globe.

In order that confidence may be placed in the estimates now presented, it may be proper to subjoin a statement of the modes in which the admeasurements were made, and the calculations based upon them were accomplished.

After having personally, and with much labor, sounded the fearfully rapid current of the Niagara River above the falls, at Black Rock, where the bottom, or bed, appears to be nearly level from one side to the other, and the depth about thirty two feet; and having repeated a course of similar admeasurements below the falls, at Queenston, where the current is more placid and the depth in the deepest place about one hundred and sixty feet; and after having lost an anchor in the course of these experiments, I finally found it necessary to have recourse to the aid of an engineer, in order to perfect all the admeasurements, which my limited time would not allow me to complete. For this purpose the services of Mr. E. R. Blackwell of Black Rock, a most skillful and accurate engineer, were engaged by me. His residence at that time, in the immediate vicinity of Black Rock, enabled him, with his zeal for the accomplishment of this object, to devote much time to completing an exact survey. By reference to the annexed sketch reduced from his elegant map of a section of Niagara River opposite Black Rock, it will be observed that thirty eight soundings were taken in three distinct ranges or lines across the channel of the river, each of the ranges being at the distance



CANADA
1626 feet
1686 feet
1783 feet
1650 feet.—12 feet.
1581 feet.—13 feet.
1546 feet.—22 feet.
1533 feet.—22 feet.
1516 feet.—13 feet.
1403 feet.—30 feet.
1331 feet.—24 feet.
1310 feet.—20 feet.
1307 feet.—30 feet.
Surface velocities.
Surface velocities.
7 1/7 miles per hour.
5 10/11 miles per hour.
1181 feet.—26 feet.
1178 feet.—24 feet.
1155 feet.—34 feet.
1147 feet.—26 feet.
1097 feet.—29 feet.
1094 feet.—32 feet.
6 9/11 miles per hour.
6 miles per hour.
1057 feet.—28 feet.
1018 feet.—32 feet.
984 feet.—32 feet.
923 feet.—28 feet.
NIAGARA RIVER.
N.
812 feet.—28 feet.
8 miles per hour.
7 1/7 miles per hour.
752 feet.—32 feet.
652 feet.—32 feet.
640 feet.—28 feet.
6 10/11 miles per hour.
5 15/27 miles per hour.
577 feet.—28 feet.
551 feet.—28 feet.
534 feet.—30 feet.
495 feet.—30 feet.
490 feet.—24 feet.
419 feet.—24 feet.
6 3/7 miles per hour.
6 miles per hour.
362 feet.—22 feet.
341 feet.—30 feet.
292 feet.—30 feet.
220 feet.—23 feet.
219 feet.—28 feet.
172 feet.—28 feet.
162 feet.—21 feet.
55 feet.—20 feet.
20 feet.—20 feet.
20 feet.—22 feet.
Pier
Black Rock Harbor
Erie Canal

of six hundred and sixty feet apart.* After thus obtaining three cross sections of the volume of the current, whereby its area or dimensions were ascertained, the velocity of the surface was then found in ten different places between these three lines, by noting the time in which floating bodies set adrift in different parts of the width of the river, were borne down from one sectional line to the distance of six hundred and sixty feet to the next sectional line below it. All these admeasurements were made with every attention to accuracy.

Having thus found by experiment the velocity of the surface of the stream, the average or mean velocity of the bottom and middle, as well as of the surface, was ascertained by means of the formula established by Eytelwein $\left(V=\frac{v}{10}\times 9\right)$ which for measuring the volume of water flowing in rivers of great depth, I consider to be a closer approximation to accuracy than those established by Prony and other philosophers, who have investigated the subject of the discharge of water flowing down the inclined planes of the beds of rivers. These calculations have been carefully revised; and the results stated may therefore be deemed as a sufficiently accurate estimate of the volume of water that flows from Lake Erie.

Allowing about 374,000 cubic feet of water (by estimate) to flow through the harbor of Black Rock per second, as indicated on the map, the results of these calculations show, that about 22,440,000 cubic feet, or 167,862,420 gallons, weighing 701,250 tons, or 1,402,500,000 lbs. of water, flow out of Lake Erie every minute, and become precipitated over the cliffs of rocks at the grand cataract of the Falls of Niagara.

Estimating the perpendicular descent of the waters of the grand cataract to be one hundred and sixty feet, and making the usual allowance of one third part for waste of effective power in the practical application of water to water-wheels; and also estimating the power of a horse to be equal to a force that will raise a weight of 33,000 pounds one foot high in one minute, which is Watt and Boulton's standard, we obtain the following results:

* In the preceding map the left hand column of figures in each section represents the distance of each sounding from the American shore, and the right hand column the depth of the soundings. The distance of the soundings from each other may be found by subtracting each measurement from the one next above it. The arrow denotes both the direction of the current and the point of compass.

$$\left.\frac{1{,}402{,}500{,}000 \text{ lbs. of water} \times 160 \text{ feet of descent}}{33{,}000}\right\} - \frac{1}{3} = 4{,}533{,}334$$

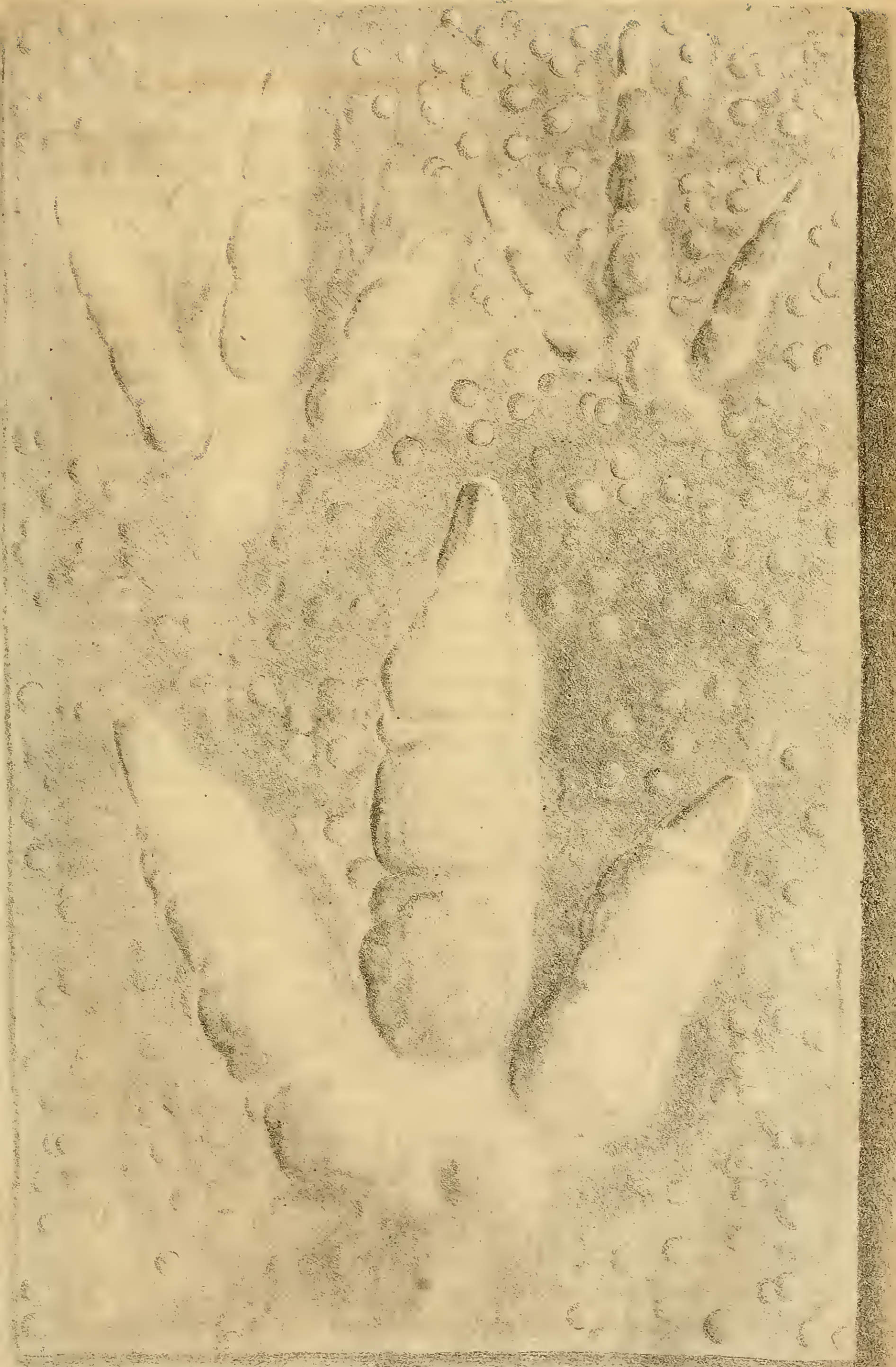
horse-power, which is the measure of the mechanical force, or motive power, that the waterfall of Niagara is capable of imparting.

It has been estimated by Mr. Baines, in his history of the Cotton Manufactures of the United Kingdom of Great Britain in 1835, that the motive power employed to operate the machinery of all the cotton mills in Great Britain, was then equal to that of about

33,000 horses, imparted by the agency of steam.
11,000 " " " waterfalls.
100,000 horse power he estimated to be employed to operate the the woolen, flax, and other mills and mechanical operations.
50,000 horse power for propelling the machinery of steamboats
——— and coal mines.
194,000 horse power in 1835.
Supposing about twenty per cent. to have been added to to this motive power in the increase of locomotive engines for railways and steamboats, as well as for various
39,000 manufacturing purposes, since 1835, we add to this ag-
——— gregate 39,000 horse power more.
233,000 horse power may be taken to be the aggregate of motive power of all the steam engines and improved waterfalls of Great Britain; which, it will be perceived, is only one nineteenth part of the effective water power of Niagara falls.

When it is considered that the water power of the cataract of Niagara is unceasing, by night as well as by day, and that the power as calculated above for practical purposes in Great Britain is only applied on an average about eleven hours per day, during six days of the week, it may be assumed that the motive power of Niagara falls is at least forty fold of the aggregate of all the water and steam power employed in Great Britain; and probably equal to the aggregate of all the motive power employed for mechanical purposes on this earth.

The surface of Lake Erie is found to be three hundred and thirty one feet above the level of the surface of Lake Ontario, and five hundred and sixty five feet above that of the ocean. The descent of the waters of Niagara River in the few miles of distance between Black Rock and Queenston, is about one hundred and seventy one feet, exclusive of the grand cataract itself, forming a succession of rapids, which in some places present to view the



J. Deane del. on Stone by W. Sharp

Fossil Footmarks from Turners Falls, near Greenfield Mass.

Bouvé & Sharp Lith.rs Boston.

sublime spectacle of the agitated surface of the ocean in a storm; and these rapids continue to occur during the subsequent descent of the river St. Lawrence, from the level of Lake Ontario to that of the sea, making in the aggregate above threefold of the waterfall of the grand cataract, and consequently one hundred and twenty fold of all the physical power derived from the use of all the waterfalls and steam engines employed as above stated in Great Britain, omitting to take into account the several huge rivers that are tributaries of the St. Lawrence. Such, and on so great a scale, are the ordinary operations of the impulses of physical power employed in the "mechanics of nature," in governing the movements of the waters of a single river, exceeding many fold the portion of physical forces rendered available and employed by all the inhabitants of the earth, as a motive power in the "mechanics of the arts." There is thus furnished an impressive lesson to humble the pride of man in his boasted achievements of the triumphs of mind over inert matter. It is well that these considerations should occur to the spectator, whilst he regards the cataract of Niagara; for no where is there exhibited on this earth a more impressive spectacle of the display of energetic physical power. Cold and indifferent, indeed, to the highest attributes of omnipotent excellence must be the mind of that human being, who can raise his eyes from the contemplation of this sublime work of nature, without a glow of fervent admiration of the "might, majesty and power" of nature's God.

Providence, R. I., Sept. 15, 1843.

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## Art. VIII.—*On the Fossil Footmarks of Turner's Falls, Massachusetts;* by James Deane, M. D.—(with a plate.)

The fine cataract of the Connecticut River that bears the name of Turner's Falls, occurs soon after the entrance of this stream upon the limits of Massachusetts. It receives this distinctive appellation in memory of a military commander, who in the time of Philip's wars, with the loss of a single man of his party, slaughtered in this place three hundred Indians in one encampment. It was however a brief triumph, for he was cut off and slain in his retreat from the contest of extermination. Unlike the prevailing quietness that distinguishes this lovely river, in its passage through the alluvial plains of Massachusetts and Connecticut, it is here in the distance of a few miles, precipitated over three successive cataracts with intermediate rapids. The scenery of Turner's Falls is unsurpassed in New England for picturesque beauty. From an eminence below the falls, the eye commands a fine view of the cataract and surrounding hills. The river emerges into view a short distance above the rocky barrier, where its surface is still as a mountain lake, but below this boundary, having fallen over it with a power that makes the earth tremble, it rushes over the rocks in an opposite direction, and is immediately lost in the chasms of the hills. The narrow compass of the horizon and an air of solitude that pervades the region, is in full contrast with the expanded valley and quiet loveliness that reigns undisturbed above and below the falls, which have been appropriately called the miniature of Niagara.

To the geologist it is a centre of peculiar attractions. He can here witness the junction of trap and sandstone under most favorable circumstances, the contact being perceptible for the space of a mile. The eastern limit of the sandstone basin is bounded by regions of granite, and the western by hills of mica slate, while in the northern neighborhood beds of limestone and primitive slates occur. Thus in an area of a few miles, no less than six distinct rock formations occur. An examination of the cataract seems to leave no doubt that its rocky structure was heaved up by the mechanical agency of the igneous rock which is in close proximity and parallel with it. The direction of the fall is irregular, but at intervals there are several eminences, which are crowned with diminutive trees. When the river passes the falls, it strikes directly against the trap or greenstone dyke, which gives a new direction to its current.

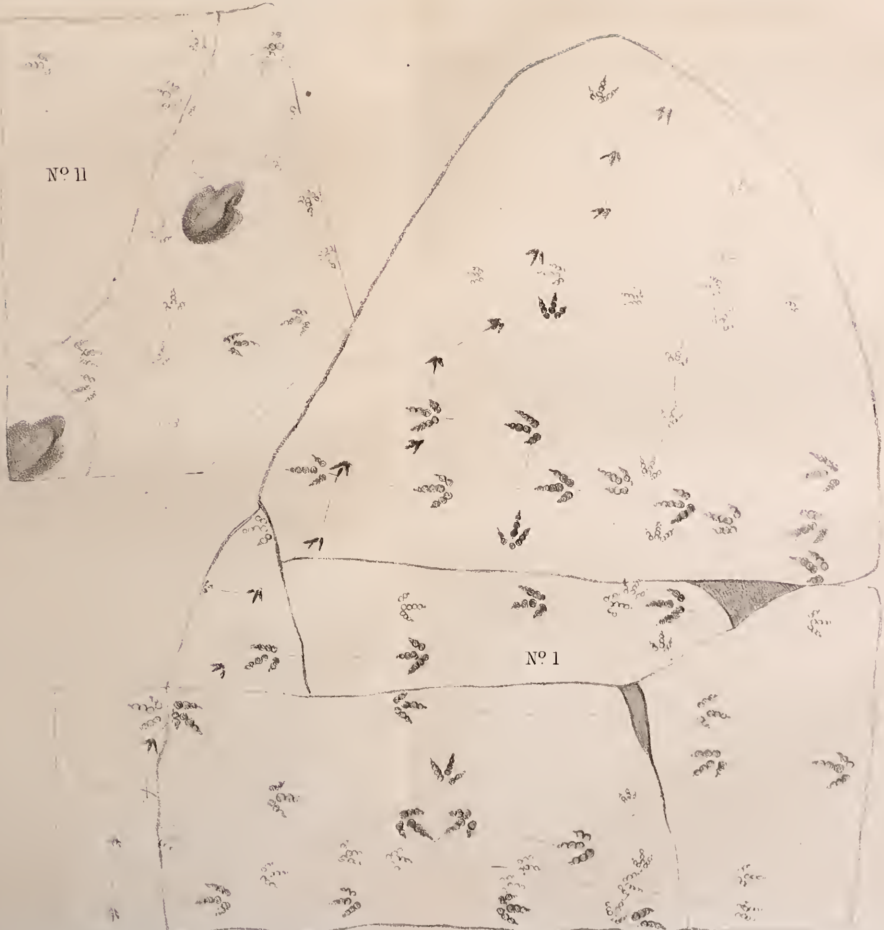
But the intent of this paper is to notice some peculiarities of the sandstone beds thus uplifted from their original positions, inasmuch as the exploration of their strata reveals the existence of *birds* at a period of time coeval with the deposition of this ancient rock. The readers of this Journal are already aware that their existence during this remote geological epoch is now fully established, and it is to carry on the illustrations, and accumulate the facts that bear upon this very interesting subject, that it is still presented. And it is perhaps doubtful if any locality of fossil footmarks furnishes such pure examples, as that of Turner's

Falls, although unfortunately it is the least prolific of all. By glancing at the plate it will be seen that the essential characters of the feet of living birds, are accurately demonstrated, and the analogy is calculated to fill us with astonishment. How an impression of a fleshy foot could have been made in yielding clay, and to the minutest touch preserved through a period of time so vast, seems without deep reflection to be incomprehensible; yet these are living witnesses that not only prove the immutability of the creative design, but reveal to us a faithful page in the history of the earth long, long antecedent to the creation of man.

It is rare to find a stratum containing these footprints exactly as they were made by the animal, without having suffered change. They are usually more or less distorted or obliterated by the too soft nature of the mud, the coarseness of the materials, and by many other circumstances which we may easily see would deface them, so that, although the general form of the foot may be apparent, the minute traces of its appendages are almost invariably lost. In general, except in thick-toed species, we cannot discover the distinct evidences of phalangeal structure of the toes, each toe appearing to be formed of a single joint, and seldom terminated by a claw. But, a few specimens hitherto discovered at this locality, completely developed the true characters of the foot, its ranks of joints, its claws and integuments. So far as I have ever seen, the faultless impressions are upon shales of the finest texture, with a smooth glossy surface, such as would retain the beautiful impressions of rain-drops. This kind of surface containing footmarks is exceedingly rare; I have seen but few detached examples, until recently it has been my good fortune to recover a stratum containing in all more than one hundred most beautiful impressions of the feet of four or five varieties of birds, the entire surface being also pitted by a shower of fossil rain-drops. By reference to the plate, it will be perceived that the fragments of this stratum are arranged in three distinct examples, correctly delineated upon a scale of one inch to one foot. The slabs are perfectly smooth on the inferior surface, and are about two inches in thickness.

In the examination of these splendid relics, the first impression of the mind is astonishment at the perfect preservation of the impressions, their wonderful fidelity to nature, and the harmony that prevails among so many lines of footsteps occurring upon such narrow dimensions. Numerous as they are, there is yet no confusion, the successive footsteps of each row bearing a just relation to each other. There appear to be three principal varieties, or perhaps sizes of impressions, each of which is accurately illustrated by the drawings, which were taken by my own hand. It is not however strictly easy to decide that these are after all distinct varieties, for setting aside the difference in size, there is great resemblance in them, yet in other respects they appear to be distinct, as is indicated by the relative length of stride and some other peculiarities. The large foot, which has received the name of *Ornithichnites Fulicoides*, (Trans. Assoc. Am. Geol. Vol. I, p. 258,) has an average length of stride of rather more than twelve inches, while the middle size, one fourth as large, has a stride of twenty to twenty three inches! It will also be seen from the plate that the zigzag direction of the steps of the *O. Fulicoides*, indicates a heavy short-legged bird, the centre of gravity falling far within the inner toe, while this line passes through or very near the centre of the other. This therefore seems to point out that the bird must have had relatively very long legs, unless we suppose, what is quite possible, that this was the running gait of a young bird. The small track is very beautiful; it is feebly impressed, from which we may infer that it was a light bird, yet in the anatomy of the feet and the great distance these organs are separated, it bears a strong affinity to the *O. Fulicoides*. Whether these birds were or were not distinct species, they were nevertheless gregarious in their nature, as is shown by the fact that they traversed the region together, and if we separate them into generic classes, it must be upon the nicest discrimination, although the structure of the foot is so beautifully cast.

The impression of a medallion is not more sharp and clear than are most of these imprints, and it may be proper to observe that this remarkable preservation may be ascribed to the circumstance that the entire surface of the stratum was incrusted with a layer of micaceous sandstone, adhering so firmly that it would not cleave off, thereby requiring the laborious and skillful application of the chisel. The appearance of this shining layer, which is of a gray color, while the fossil slab is a dark red, seems to carry the probability that it was washed or blown over the latter while in a state of loose sand, thus filling up the footprints and rain-drops, and preserving them unchanged until the present day—unchanged




J Deane del

on Stone by W. Sharp

Fossil Footmarks from Turners' Falls, near Greenfield, Mass.

Pain & Sharp lith[rs] Boston

in the smallest particular, so far as relates merely to configuration, nothing being obliterated; the precise form of the nails or claws and joints, and in the deep impressions, of the metatarsal or heel bone, being exquisitely preserved.

The great slab, which is about six by eight feet in dimensions, contains over seventy five impressions. There are five rows of *O. Fulicoides* of five and six tracks each, three rows of the medium size of four tracks each, one row of the small size of fourteen consecutive impressions, and another row of a like number, made when the material of the slab was too soft to retain the peculiarities of structure, besides several other rows varying from two to six impressions each. It is a singular circumstance that of this great number, two or more footsteps, with perhaps one or two exceptions, nowhere fall upon the same spot.

The next slab in importance contains three rows of *O. Fulicoides* of three and four impressions each, one of the second size of two, and one of the smallest size of six footsteps each, besides several others. Although this is inferior in dimensions to the latter, yet it is an incomparable specimen. For purity of impression it is unsurpassed, and the living reality of the rain-drops, the beautiful color of the stone, its sound texture and lightness, renders it a fit member for any collection of organic remains. Nor is the third slab of inferior interest.* It has two rows of the large foot of three and two impressions each, without blemish; one of the second size of two tracks, and two of the third with five and six footprints each. Besides it has a row of two impressions of an immense bird with a short broad foot, five inches by six, apparently palmated. It must have been as large as the African ostrich, for the stratum bent beneath its great weight and impressed that next below. The stride is twenty nine inches.

These magnificent specimens have been inspected by Prof. Hitchcock and by Prof. Silliman; to the former properly belongs the technical and complete description of them as his peculiar province. I therefore most willingly decline this difficult performance in respect to him, for to his successful labors, the subject of fossil footmarks owes its claims as an essential element of the science of organic geology.

Greenfield, Mass., Nov. 11, 1843.

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* Omitted in the plate.

## Art. IX.—*A New Process for preparing Gallic Acid;* by Edward N. Kent.

TO THE EDITORS OF THE AMERICAN JOURNAL OF SCIENCE AND ARTS.

*Gentlemen*—During a recent examination of black ink, which had been prepared by exposure to the atmosphere for three months, I found it contained a quantity of free gallic acid, protosulphate of iron, and pertannate of iron.

Having previously experienced the inconvenience of waiting two months to prepare gallic acid by the old process, and as it is not an article of commerce, it occurred to me that if the acid in the ink could be easily isolated, it would form a valuable process for its preparation when wanted for immediate use, as ink can always be readily obtained containing the acid ready formed.

I therefore agitated a pint of ink with an equal measure of sulphuric ether,* left it at rest for a few moments to separate, and then decanted the ether, and found it had taken up gallic acid to the exclusion of the other constituents, except a light yellow color and odor of cloves, these having been put into the ink. I then distilled the ethereal solution nearly to dryness; the residue crystallized on cooling. I returned the distilled ether on the ink, and repeated the process the third time, and after crystallizing three times and drying, obtained twenty eight grains of colorless gallic acid.

I then distilled off from the ink a little remaining ether, and the ink was left as good for *ordinary* purposes as before; and the only expense in the preparation of the acid was the loss by evaporation of about one ounce of the ether.

Most of the inks which I have tried gave the same result when treated with ether. Some however which have been prepared by boiling the nutgalls, and exposure for a few days only, yielded principally tannic acid. It is therefore advisable to test the ink with gelatine before attempting to prepare gallic acid by this process. Yours, very respectfully,

Edward N. Kent.

New York, October 9th, 1843.

* I have repeated Mr. Kent's experiment successfully: care must be had that the ether is quite free from alcohol, which commercial ether never is. As gallic acid is more soluble in alcohol than in ether, the process is only partially successful when alcohol is present.—B. S. Jr.

ART. X.—*Solution to a Case in Sailing;* by W. CHAUVENET, A. M., Professor of Mathematics in the U. S. Naval School, Philadelphia.

IN a late treatise upon navigation, the following problem is solved by middle-latitude sailing, and the solution is accompanied with a note declaring that this case "cannot be solved by Mercator's sailing;"* and by referring to the various accessible works upon navigation I cannot find that any rigid solution has ever been printed, although it certainly cannot be regarded as difficult. The true solution may have been overlooked because it cannot be deduced by comparing the *similar triangles* employed in all popular works to illustrate Mercator's sailing; or it may have been neglected as unimportant because the case can seldom occur in practice. The problem however is not without interest, and a solution of it, theoretically accurate, though unnecessary to the advanced mathematician, may be acceptable to the student of navigation.

*Problem.*—"A ship sails in the N. W. quarter 248 miles ($d$) till her departure is 135 miles ($p$), and her difference of longitude 310 miles (D). Required her course (C), the latitude left and the latitude come to?"

*Solution.*—By putting $l$= proper difference of latitude, P= meridional difference of latitude, we have immediately from the data

$$l=\sqrt{d^2-p^2},\ \sin. C=\frac{p}{d},\ P=D \text{ cotang. } C,\quad (1).$$

Now to find the two latitudes, represent them by $L+\frac{1}{2}l$ and $L-\frac{1}{2}l$, and let the meridional parts for these latitudes be A and A′. Then since an arc of Mercator's meridian from the equator to any latitude (the radius of the earth being 1) is equal to *the Naperian logarithm of the cotangent of half the co-latitude,* we have

$$A=\text{Nap. log. cotang. } \tfrac{1}{2}[90^\circ-(L+\tfrac{1}{2}l)]$$
$$A'=\text{Nap. log. cotang. } \tfrac{1}{2}[90^\circ-(L-\tfrac{1}{2}l)]$$

which reduced to nautical miles by multiplying by the radius $R=\frac{360\times 60}{2\pi}=3437.7$, and expressed in common logarithms by

* See Riddle's Navigation, (fourth edition,) pp. 177, 178.

dividing by the modulus M=.43429, become

$$A=7915.7 \text{ log. cotang. } \tfrac{1}{2}(90^\circ-L-\tfrac{1}{2}l)$$

$$A'=7915.7 \text{ log. cotang. } \tfrac{1}{2}(90^\circ-L+\tfrac{1}{2}l)$$

From these we obtain

$A-A'=P=7915.7[\text{log. cotang. } \tfrac{1}{2}(90^\circ-L-\tfrac{1}{2}l)-\text{log. cotang. } \tfrac{1}{2}(90^\circ-L+\tfrac{1}{2}l)]$:

$$\frac{P}{7915.7}=\text{log.}\frac{\text{cotang.}\tfrac{1}{2}(90^\circ-L-\tfrac{1}{2}l)}{\text{cotang.}\tfrac{1}{2}(90^\circ-L+\tfrac{1}{2}l)}=\text{log.}\frac{\text{tang.}\tfrac{1}{2}(90^\circ-L+\tfrac{1}{2}l)}{\text{tang.}\tfrac{1}{2}(90^\circ-L-\tfrac{1}{2}l)};$$

and if $\frac{P}{7915.7}=\text{log. } n$, we have

$$n=\frac{\text{tang.}\tfrac{1}{2}(90^\circ-L+\tfrac{1}{2}l)}{\text{tang.}\tfrac{1}{2}(90^\circ-L-\tfrac{1}{2}l)}=\frac{\text{cos.}L+\text{sin.}\tfrac{1}{2}l}{\text{cos.}L-\text{sin.}\tfrac{1}{2}l};$$

from which we find $\text{cos. } L=\frac{n+1}{n-1}\text{ sin.}\tfrac{1}{2}l$, (2).

To facilitate the computation by logarithms, put $n=\text{cotang.}\,\varphi$, then $\frac{n+1}{n-1}=\text{tang.}(45^\circ+\varphi)$, and equation (2) becomes

$$\text{cos.}L=\text{tang. }(45^\circ+\varphi)\text{sin.}\tfrac{1}{2}l, \qquad (3),$$

which with the equation

$$\text{log. cotang. } \varphi=\frac{P}{7915.7}=\frac{D\text{ cotang. } C}{7915.7}, \qquad (4)$$

furnishes a very easy solution to the question.

In the example proposed we find by equations (1), C=32° 59′, $l$=208′. The computation of equations (4) and (3) will be as follows:

| | | |
|---|---|---|
| C=32° 59′, . . | *l.* cotang. | +0.18776 |
| D=310, . . . . | | +2.49136 |
| Log. 7915.7, . . . . | | −3.89849 |
| Log. cotang. $\varphi$=0.06034, . . . . | | 8.78063 |
| $\varphi$=41° 02′ | | |
| 45°+$\varphi$=86° 02′, . . . | *l.* tang. | 1.15900 |
| $\tfrac{1}{2}l$=104′, . . . | *l.* sin. | 8.48069 |
| L=64° 08′, . . . | *l.* cos. | 9.63969 |

$L+\tfrac{1}{2}l$=65° 52′, $L-\tfrac{1}{2}l$=62° 24′. The latitudes found by middle-latitude sailing, are 65° 55′, and 62° 27′.

U. S. Naval Asylum, Philadelphia, August, 1843.

Art. XI.—*A Monography of the North American species of the genus Equisetum*, by Prof. Alexander Braun, of Carlsruhe, Germany; *translated from the author's manuscript, and with some additions*, by George Engelmann, M. D., of St. Louis, Missouri.

My early friend and indefatigable correspondent, Prof. Alex. Braun, having placed in my hands a manuscript monography of the genus Equisetum, full of original views, and offering a very lucid exposition of this interesting genus, I believe I am rendering a service to the lovers of botany in this country by translating and publishing this paper; to which I add a few remarks of my own, chiefly relating to the two new species of the Western United States. G. E.

Before we come to the description of the different species, it will be necessary to explain the structure of the stems of the *Equiseta*, which afford much more characteristic distinctions than their fructification.

The *Equiseta* have simple or verticillately branched stems, which are all grooved (amongst the American species only *E. eburneum* makes an exception, as far as regards the stem, but not the branches); they have verticillate leaves, which are connected in sheaths; their points only being free, and forming what is called the teeth of the sheaths. The carinæ, or ridges of the stem, which separate the grooves (*valleculæ*) are either smooth, (*E. limosum*, *E. lævigatum*, etc.) or rough from siliceous tubercles, (*E. robustum*, *E. hyemale*, etc.): they are simple, (*E. limosum*, *E. robustum*,) or divided by a furrow (*sulcus*) along their back, so as to form two more or less distinct ridges (*E. hyemale*, *E. variegatum*, branches of *E. eburneum*). In one species (*E. scirpoides*,) the furrows dividing the carinæ become as large and deep as the grooves themselves, so that the apparent number of the carinæ is double that of the leaves.

In all the *Equiseta* with green stems, (but not in the discolored fertile ones of *E. arvense* and *E. eburneum*, or the white sterile ones of the latter,) the epidermis of the grooves or valleculæ is perforated by stomata. In the first division, these stomata are irregularly distributed over the surface of the grooves (therefore

EQUISETA SPEIROPORA); in the second division they are disposed regularly in two ranges on the sides of the grooves (E. STICHOPORA). These ranges consist either of one series or row of stomata each (as in all the northern species), or of two or more rows (as in many tropical ones). The stomata are only found in the grooves, never in the secondary furrows, even when these are of equal size and depth with the former.

The sheaths consist of united verticillate leaves, free only on the points, which constitute the *teeth;* and these teeth correspond in number and position with the carinæ of the stem; they are either persistent or deciduous. The leaves have either a single medial carina, or this carina is divided by a furrow, so as to appear double; or sometimes the margins of the leaves are elevated and form two lateral carinæ; thus the leaves may present from one to four carinæ. The furrow which sometimes divides the principal carina is the *carinal furrow;* and another which is frequently found on the connecting line or the commissure of two leaves is the *commissural furrow.*

The section of the stem exhibits the following structure. In the centre is a larger or smaller air-cavity or hollow space, *lacuna,* (wanting only in *E. scirpoides*); and around this a circle of generally much smaller air-cavities which correspond with the grooves or valleculæ, and which we therefore call *vallecular air cavities.* These are wanting in only one species, viz. *E. limosum.* Exterior to these again is a circle of alternating and still smaller air-cavities just under, or corresponding with the carinæ, (*carinal air-cavities,*) but they are sometimes very minute or nearly obliterated.

In some *Equiseta* there is no distinction of fertile and sterile stems: such are E. HOMOPHYADICA. Some of these have annual stems, (E. ÆSTIVALIA, *Summer-Equiseta,*) such as *E. palustre,* and *E. limosum:* others have perennial stems, not perishing in winter, (E. HYEMALIA, *Winter-Equiseta,*) such as *E. hyemale, E. scirpoides,* etc. In a second division, the fertile stems are different from the sterile ones; the latter only being herbaceous, branching and persistent through the season, while the fertile are discolored and simple: such are E. HETEROPHYADICA. In some of these the fertile stems are deciduous after fructification (E. VERNALIA, *Vernal Equiseta,*) as in *E. arvense* and *E. eburneum:* others, after fructification, produce verticillate herbaceous branches, and become similar to the sterile ones and persistent through the season, (E. SUBVERNALIA, *Subvernal Equiseta*,) as is the case in *E. sylvaticum* and *E. pratense.*

## EQUISETUM, *Linn.*

§1. EQUISETA SPEIROPORA: stomata irregularly dispersed over the whole surface of the grooves.

* *Heterophyadica:* fertile stems different from the sterile ones; the former early and discolored; the latter later and herbaceous.

† *Ametabola* (*Vernal Equiseta*): fertile stems simple, never herbaceous, deciduous before the full development of the sterile stems.

1. E. ARVENSE, *Linn.*—Sterile stems grooved, smoothish; sheaths consisting of about eleven 1-carinate leaves; carinæ with a very slight furrow on the back; the commissural furrows between them slight; carinæ of the simple branches compressed, rough; sheaths consisting of four 1-carinate leaves, with herbaceous ovate-acuminate subsquarrose teeth. Fertile stems simple; the sheaths consisting of 2-carinate leaves, which, at first connate up to the apex, finally separate into short teeth.

The sheaths of the fertile and sterile stems are composed (according to the size of the specimens) of from 7 to 15, but generally 10 to 13 leaves; the sheaths of the branches are mostly 4-, seldom 3- or 5-toothed. The summit of the sterile stem is attenuated, and like one of the branches.—We distinguish the following varieties.

*β.* NEMOROSUM, *A. Braun.* Large, 12 to 20 inches high; the branches with a few branchlets.—*E. pratense*, Roth and others, not Ehrh. In specimens from Missouri, the sheaths have 12 to 15 teeth; the fertile stems are 12 to 15, and the sterile ones 15 to 20 inches high: branches frequently 6 or 7 inches long.

*γ.* DECUMBENS, *Meyer, Chl. Hanov.* Sterile stems branching from the base, procumbent. In Missouri, sheaths with 7 to 8 teeth: stems 4 to 6 inches high; the lowest branches with a few branchlets.

*δ.* SEROTINUM, *Meyer, Chl. Hanov.* The usually sterile herbaceous stems also with fructification.—*E. campestre*, Schultz, prodr. fl. Starg.

Hab. Europe, Northern Asia, North America, from Greenland to the Northern States and Virginia, (*Pursh*,) to Kentucky, (*Short*,) Missouri, (*Engelmann, Riehl*,) the Rocky Mountains, (*Fremont*,) and the North West coast, (*Chamisso*.) β. Germany, Kentucky, (*Short*,) Missouri, in fertile woods. γ. Germany, Missouri, in dry pastures, road sides. δ. Very rare, in Germany.

2. E. EBURNEUM, *Schreb*.—Sterile stems very smooth, ivory white; sheaths consisting of about thirty bicarinate leaves, separated by deep commissural furrows; carinæ of the simple branches again deeply furrowed, scabrous; their sheaths consisting of four (sometimes five) bicarinate leaves, with herbaceous erect subulate fragile teeth. Fertile stems simple, sheaths consisting of obsoletely 3-carinate leaves, with lanceolate subulate teeth.—*E. Telmateja*, Ehrh. *E. fluviatile*, Smith, Willd., Vaucher, not Hoffm. *E. decumanum*, Pallas, (Siberia,) *E. macrostachyon*, Poir. (Barbary.)

β. FRONDESCENS. Fertile stems persistent, producing herbaceous branchlets.

γ. SEROTINUM. The usually sterile stems with late fructification.

Hab. Europe, Asia, North Africa and North America, (on Lakes Erie and Superior, *Torrey*, according to Beck's Botany.)

The sheaths of the fertile and sterile stems are formed by from 20 to 40 leaves, generally 24 to 36. Sterile stems from 2 to 5 feet high.

†† *Metabola*, (*Subvernal Equiseta*): fertile stems persistent and producing herbaceous branches after fructification.

3. E. SYLVATICUM, *Linn*.—Sterile (and finally also the fertile) stems doubly branched, the branchlets curved downwards; stems grooved, fertile ones nearly smooth; carinæ of the sterile ones scabrous, in two rows; sheaths consisting of about twelve 1-carinate leaves with shallow commissural furrows between them; their scarious elongated points partly connate, so that the sheaths appear to be 3- or 4-lobed; carinæ of the branches slightly furrowed, somewhat scabrous; carinæ of the branchlets compressed, smooth, their sheaths funnel-shaped, consisting of 4 or 5 (on the branches) and 3 (on the branchlets,) 1-carinate leaves with lanceolate-acuminate divergent teeth.

Hab. Europe, Asia, North America, from Labrador (*Unger*,) to Massachusetts, (*Oakes*,) Pennsylvania, (*Muhlenberg*,) Virginia, (*Pursh*,) and Ohio, (*Riehl*.)

The sheaths of the stem are formed by 8 to 17 (generally 10 to 14) leaves whose points are connected in 2 to 4 or more lobes, which, before the development of branches, distinguish the fertile stem from *E. arvense*. *E. sylvaticum* as well as *E. arvense* have tubers on the creeping rhizoma, which Prof. Braun could not find in *E. eburneum;* the other species have certainly none.

4. E. PRATENSE, *Ehrh.*—Sterile (and finally also the fertile) stems with simple straight branches, both grooved; carinæ scabrous, in one row; sheaths consisting of about 11 leaves, with very shallow carinal and deeper commissural furrows, teeth scarious, ovate-lanceolate, and all free; carinæ of the branches slightly scabrous, much compressed; urceolate sheaths consisting of three 1-carinate leaves with herbaceous erect very short and somewhat obtuse teeth.—*E. umbrosum*, Meyer, in Willd. *E. Ehrharti*, Meyer, Chl. Hanov. *E. amphibolum*, Retz. *E. triquetrum*, Bory. *E. Drummondii*, Hook.

Hab. This species appears to inhabit extensively the northern countries of Europe and Asia; it is rare in Scotland, common in Scandinavia, in the North of Germany, in Russia and Siberia; also in the Alps and Pyrenees; in Arctic America and Greenland according to Sprengel. It is easily distinguished from the foregoing, much more common, species by the shorter, never connate teeth of the sheaths of the stem, the 3-teethed sheaths of the branches, and the absence of branchlets.

** *Homophyadica*, (*Summer Equiseta*): fertile and sterile stems similar, both herbaceous and contemporaneous; or all the stems fertile. (All the known species belonging to this section have annual stems, not persistent in winter.)

5. E. PALUSTRE, *Linn.*—Stems generally with simple verticillate branches, deeply grooved, somewhat scabrous; vallecular air cavities large, the carinal ones very small; sheaths loose, consisting of about 8 leaves separated by shallow commissural furrows and above with carinal ones; teeth lanceolate, acute, dark ferruginous, with broad membranaceous margins; branches smilar to the stem, with acuminate adpressed somewhat sphacelate teeth of the mostly 5-leaved sheaths. *E. pratense*, Reichenb., not Ehrh. nor Roth.

*β.* SIMPLICISSIMUM. Stems without branches.

*γ.* POLYSTACHYUM. Branches elongated, bearing heads.

Hab. Europe, North America, Arctic America to Virginia, (*Beck's Botany.*)—Sheaths of the stem with 6 to 10, mostly 7 to 9 teeth. A very polymorphous species. Nearly related to this species is *E. Bogotense*, Humb., Bonpl. and Kunth. (Syn. *E. stipulaceum*, Vaucher, and *E. flagelliferum*, Kunze.)

6. E. LIMOSUM, *Linn.*—Stems tall, erect, generally above with simple branches, the sterile ones much elongated; grooved, nearly smooth; vallecular air-cavities none, the carinal ones small, the central cavity very large; sheaths adpressed, consisting of about eighteen 1-carinate not furrowed leaves, with linear acute blackish teeth nearly destitute of a membranaceous margin; branches somewhat scabrous; sheaths herbaceous, consisting of about six leaves with linear-setaceous points.—*E. limosum* and *E. fluviatile*, Hoffm. and other authors. *E. Heleocharis*, Ehrh.

β. MINUS, *A. Braun.* Stems simple, somewhat scabrous, sheaths consisting of about eleven leaves.—*E. uliginosum*, Muhlenb., Willd.

γ. POLYSTACHYUM. With numerous short verticillate, floriferous branches.

Hab. In ditches and swamps in Europe. In the United States in Pennsylvania, (*Wolle*,) New York, (*H. Eaton*,) and Wisconsin, (*Lapham in herb. Short.*) β. in North America, Newfoundland, (*La Pylaie*,) Northern States, (*Beck's Botany*,) Pennsylvania, (*Muhlenberg*,) Virginia, (*Pursh.*) Also in Germany in peat morasses, (*A. Braun.*) Easily distinguished from *E. palustre*, by the structure of the stem and by the teeth; though at first sight var. β. considerably resembles some forms of the former. The sheaths are composed of 10 to 22 leaves, commonly 17 to 20, in the American specimens examined by me of 15 to 21, in β. of 10 to 12 leaves. Rhizoma never tuberous. The branches are generally developed after fructification.

§ 2. EQUISETA STICHOPORA, (*Winter-Equiseta*): Stomata disposed in two distinct ranges on each side of the groove; each range formed by one or more rows of stomata. (All the known species of this division, have hardy evergreen stems.)

Most of the tropical Equiseta, as well also as some of the most northern species, (*E. scirpoides* and *E. boreale*,) belong to this large and very difficult division. They all contain more silex beneath the cuticle than the *E. speiropora*, which accounts for their hardness and durability. Their distinguishing characteristic is the disposition of the stomata in two ranges, separated by a free interstice. In the European and North American species, these ranges consist of a single row of stomata; in many tropical species each range has two or more rows. The spikes are mostly acute.

* *Heterophyadica.* (It is questionable whether any species exists belonging to this section. *E. myriochæton*, Schlecht. and Cham. from Mexico, so far known only from sterile specimens, might possibly prove to have different and earlier fertile stems.)

** *Homophyadica.*

† Ranges of stömata consisting each of one row.

7. E. LÆVIGATUM, *A. Braun.*—Stems tall, erect, simple or somewhat branching; carinæ convex, obtuse, smooth; grooves shallow on each side, with a single series of stomata; vallecular air-cavities small, the carinal ones very minute; central cavity large; sheaths elongated, adpressed, with a black limb, consisting of about twenty two leaves with one carina at base and (by the elevation of the margins and depressions of the middle) two towards the point; points linear-subulate, sphacelate, caducous, leaving a truncate-dentate margin to the sheath; branches somewhat rough; sheaths with about eight indistinctly 3-carinate leaves; points persistent, subulate, sphacelate with a narrow membranaceous margin.

β. SCABRELLUM, *Engelm.*—Carinæ more elevated, somewhat rough with small tubercles; leaves above with two rather rough lateral carinæ, convex in the middle; teeth subulate, black at the base, membranaceous on the margin and towards the point, mostly persistent.

γ. ELATUM, *Engelm.*—Very tall; sheaths with about thirty leaves, the points linear-lanceolate, membranaceous, irregularly deciduous, leaving a ragged truncate-dentate black margin.

Hab. On poor clayey soil, with Andropogon and other coarse grasses, at the foot of the rocky Mississippi hills, on the banks of the river, below St. Louis, (*N. Riehl,*) who discovered it 1840, (*G. Engelmann*) α. and β. γ. Near Newbern, North Carolina, (*Loomis & Croom in herb. Short.*) Mr. Curtis informs me that this is probably the only species in that section.

In size and manner of growth this new species is closely allied to *E. hyemale*, and the larger variety to *E. robustum;* but it is easily distinguished by its smoothness, its long green sheaths, with a narrow black limb, and its darker green color; in some of these respects it approaches to *E. limosum*, but differs by the deciduous teeth, the regularly disposed stomata, the structure of the stem, etc. It is generally one and a half to two, and even three feet high; but var. γ. attains, according to the label in Prof. Short's herbarium, a height of four feet and a half. The stems are simple, or occasionally branched, with 20 to 24 carinæ, but I have collected specimens with from 18 to 27 carinæ. Generally they are perfectly smooth, but younger specimens and sometimes older ones also are somewhat rough, with rather persistent teeth, approaching the small variety of the next species, but they can always be distinguished from that by the sheaths being nearly twice as long, rarely with a black girdle at the base, more green, and by the medial carinæ of the leaves not extending to the point. (In the small variety of *E. robustum*, it is strongly marked and very rough.) The young sterile shoots with about 15 to 17 carinæ are also more rough than the fertile stems, and resemble in that respect the branches, which have 7 to 10 leaves with persistent points. The sheaths, as has been stated, have generally only a narrow black limb, but some specimens have also, especially on the lower sheaths, a black girdle at base; in one specimen I have seen the whole sheath black. The spikes are generally more obtuse than in *E. hyemale.* The var. γ. has much the appearance of *E. robustum*, and it is equally large and stout, but is very distinct in all other respects. From the very fragmentary specimens seen by me, it seems impossible to distinguish it specifically from the Missouri plant.

8. E. ROBUSTUM, *A. Braun.*—Stems very tall and stout, erect, simple or slightly branching above; carinæ narrow, rough with one line of tubercles; grooves shallow, on each side with a single series of stomata; vallecular air-cavities large, the carinal ones nearly none; central cavity very large; sheaths short, adpressed, with a black girdle above the base, rarely with a black limb, consisting of about forty (in the branches eleven) leaves, 3-carinate from the black girdle to the limb; the points ovate-subulate, sphacelate, deciduous, leaving an exactly truncate margin. *E. procerum*, Bory ined., non Pollini. *E. prœaltum*, Raf.?

β. MINUS, *Engelm.* Fertile stems with 28 to 31 carinæ, 2 to 3 feet high; points of the leaves more persistent.

γ. AFFINE, *Engelm.* Fertile stems simple, with 20 to 25 carinæ, 1 to 2 feet high; teeth subulate-aristate, mostly persistent, black, rough, finally becoming white.

Hab. Islands of the Mississippi in Louisiana, (*Bory de St. Vincent.*) Banks of Red River, (*Dr. Hale, in herb. Short.*) Banks of the Wabash and Ohio, and the Mississippi near St. Louis, also on lakes and smaller streams in that region, (*G. Engelmann.*) Banks of the Missouri up to Eau-qui-coule River, (*Geyer in Nicollet's Expedition.*) Also in the East Indies; Lahore, (*Jacquemont,*) Pondicherry, (*Belanger.*) Varieties *β*. and *γ*. near St. Louis, the first with the common form, the other with *E. lævigatum*, on poorer soil.

This stately species appears to take the place of *E. hyemale* in the Mississippi valley, at least in its middle and southern parts. It reaches a size of from three or four to even six feet, (*Geyer.*) The largest specimens from Louisiana, have 44 to 48, those from the Ohio and from St. Louis, have all from 37 to 41 carinæ, and consequently leaves. The species is distinguished from *E. hyemale* by its size, by the strictly simple row of tubercles on the ridges, and by the 3-carinate (not 4-carinate) leaves. It is a remarkable peculiarity that in old specimens, not only the teeth or points are deciduous, but also the upper part of the sheath itself down to the black girdle, giving the stems the appearance of the fossil *Calamites*, with reduced dimensions. The branches of flowering stems have usually 11 carinæ, but branches of old decaying stems, and young sterile shoots have 17 to 25 and more carinæ.

Var. *β*. offers no difficulties; but *γ*. approaches very closely, rather too much so, to the next species, whence the name. It has the same size and growth, but the sheaths appear to be shorter, their leaves never 4-carinate, and the tubercles on the carinæ of the stem constantly in one row. This variety corresponds with var. *γ*. of the next species, both being much smaller than the common forms, and much rougher also; the roughness extending to the points of the leaves and rendering them more persistent.

9. E. HYEMALE, *Linn.*—Stems tall, erect, simple, rarely with a few branches; carinæ rough with two more or less distinct rows of tubercles; grooves on each side with a single series of stomata; vallecular air-cavities large, the carinal ones minute; central cavity large; sheaths elongated, closely adpressed, with a black girdle above the base, and a black limb, consisting of about 20 (in the branches 9) narrowly linear, at base 1-carinate, above obsoletely 4-carinate leaves, with linear-subulate deciduous points, which leave a bluntly crenate margin.

*β*. PALEACEUM, *A. Braun.*—Stems smaller, sheaths with a black limb, but mostly without a black girdle, consisting of 10 to 12 evidently 4-carinate leaves; their points less deciduous, sphacelate, nearly smooth.—*E. paleaceum*, Schleicher.

γ. TRACHYODON, *A. Braun.*—Stem smaller; carinæ more plainly with two rows of tubercles, which are separated by a furrow; sheaths with a black limb, consisting of about ten evidently 4-carinate leaves, their points less deciduous, whitish or sphacelate, rough on the back.

Hab. Europe, with all the varieties; in North America, only the common form has yet been remarked: Pennsylvania, (*Muhlenberg*, *Schweinitz*,) Canada and Northern States, (*Beck's Botany*, *&c.*,) Michigan, (*Engelmann*,) to Kentucky, (*Short.*) Both varieties will doubtless be found in this country.

Specimens from the sandy shores of Manitou Island, Lake Michigan, have in the fertile stems 24 to 26 carinæ, (in the smaller sterile ones 17,) with nearly one row of tubercles; the black limb of the sheath is somewhat indistinct; leaves with 4 or sometimes (by obliteration of the carinal furrow) only 3 carinæ; teeth white, less deciduous, leaving a more exactly truncate margin. Specimens from Kentucky have 20 to 28 carinæ; tubercles nearly in one row; leaves with 4 or only 3 carinæ; very near *E. robustum*, *γ. affine!* Var. γ. is by far the roughest form; by its smaller size, and plainly 2-rowed tubercles on the carinæ, it approaches to *E. variegatum*. *E. hyemale* is a northern plant, being replaced towards the south in North America, by the larger *E. robustum*, and in Europe by a smaller species, the much-confounded *E. elongatum*, Willd., (*E. ramosum*, Schleich., *E. pannonicum*, Kit., *E. Illyricum*, Hoppe, etc.,) which extends from Southern Germany, through the whole of Southern Europe to Northern Africa, Arabia, and middle Asia, and a variety of which occurs again at the Cape of Good Hope, Isle of Bourbon, and Isle of France: but it has not yet been met with in America.

10? E. BOREALE, *Bongard.*—Found in Sitcha on the Northwest coast by Dr. Mertens, is unknown to me; perhaps a variety of *E. hyemale?* (*A. Braun.*)

11. E. VARIEGATUM, *Schleicher.*—Cæspitose; stems low, simple; carinæ rough with two rows of tubercles, separated by a furrow; the grooves larger and deeper than the furrows, on each side with a single series of stomata; vallecular air-cavities of the same width as the central cavity, the carinal ones very small; sheaths somewhat campanulate, variegated with black, consisting of about

seven 4-carinate leaves; the points persistent, ovate membranaceous, with fragile awns.

*β.* REPTANS, *A. Braun.*—Stems small, procumbent at base, sheaths consisting of about four leaves.—*E. reptans*, Wahlenb. in part. Wahlenberg comprises this variety and the following species in his *E. reptans.*

Hab. Northern Europe; also on the Alps in Central Europe, and along the rivers rising in them. Also in North America, Niagara, (*Dr. Kinnicutt*, according to *Torrey*;) Vermont, (*J. Carey*, according to *Oakes.*) In Prof. Short's herbarium, I have seen a specimen from New York, which I cannot but refer here, though the central cavity is much larger than the vallecular ones, and the 8 carinæ of the stems are nearly simple. In German specimens the sheaths have 6 to 8, rarely 9 to 10 leaves; var. *β.* growing only in higher latitudes, has four or five, very rarely only three teeth.

12. E. SCIRPOIDES, *Michx.*—Cæspitose; stems low, filiform, somewhat flexuous, simple; rough on the angles which are formed by the equally wide grooves between, and furrows on the carinæ; on each side of the grooves a single series of stomata; vallecular air-cavities large, no carinal ones, no central cavity; sheaths somewhat turbinate, variegated with black, consisting of three, rarely four, 4-carinate leaves; the points persistent, ovate, cuspidate, membranaceous, whitish.

Hab. Arctic America, (*Beck's Botany*,) Newfoundland, (*Herb. Willd.*,) Canada, (*Michx.*,) Northern States, (*Carey*, *Oakes*, and others.) Lately discovered also in Arctic Europe.

This is the smallest of all the known species, with very rarely more than three teeth in the sheaths, but always double the number of angles on the stem. Three of the grooves between these angles correspond with the leaves and are without stomata; the three alternating ones correspond with the commissure of the leaves, and have each two ranges of stomata.

†† Ranges of stomata consisting each of two or more rows.

E. GIGANTEUM, *Linn.* and others, of South America, belongs here. Several species undoubtedly have been confounded under this name, which are all nearly related to *E. robustum*, but are well distinguished by having two or three rows of stomata in each range. No North American or European species, so far as known, belongs to this section.

Art. XII.—*A Brief Notice of the Charæ of North America;* by Prof. Alexander Braun,—communicated by Dr. Engelmann.

Besides the Equiseta, Prof. Braun has devoted much attention to other families of Cryptogamous plants, such as the *Rhizocarpeæ;* of which he has lately published two new North American species of *Marsilea:* viz. *M. uncinata*, found in 1835 by the writer of this note in Arkansas; and *M. mucronata*, discovered in the year 1839 by Mr. Geyer, in Nicollet's Northwestern Expedition, along the saline prairies near Devil's Lake. Both are nearly related to *M. vestita*, Hook. & Arn. of Oregon, but very different from the European *M. quadrifolia.* But Prof. Braun's especial favorites are the *Charæ*, which he has very thoroughly investigated, and intends soon to describe monographically. As these obscure plants are seldom collected by our botanists, he has not enjoyed so good opportunities of studying American specimens as could be wished. He therefore urgently requests American botanists to aid him by the communication of their collections in this genus, (either in the way of loan or exchange,) in order that the species of this country may be more satisfactorily elucidated.* The subjoined list comprises eleven North American species, which have fallen under his notice in various European herbaria. Five of these are identical with European species; four are distinct, but nearly related forms; while two belong to a section which has no known representative in Europe. G. E.

## *Charæ of North America.*

A. Charæ epigynæ, *A. Braun.* (Nitella, *Agardh*, partly.)

1. Ch. flexilis, *Linn.* (vera?)—Sterile specimens, Pennsylvania? *Schweinitz in herb. Zeyher.* In the Merrimac, Massachusetts, *Greene.*

2. Ch. glomerulifolia, *A. Braun.*—(Subspecies of *C. flexilis.*) In the Merrimac, *Greene.*

3. Ch. mucronata, *A. Braun.*—(*C. flexilis* of authors, partly) var. Americana? A. Braun. In the Merrimac, *Greene.*

* Dr. Engelmann of St. Louis, and also Prof. Gray of Harvard University, will cheerfully take charge of parcels or communications addressed to Prof. Braun.

4. Ch. capitellata, *Elliott.*—Georgia, *Le Conte,* in different herbaria. Called *C. tenella* by Braun, before he was aware of Elliott's name. Where has Elliott described it?

5. Ch. tenuissima, *Desv.*—Not to be distinguished from European specimens. Boston, *Greene, in herb. Decaisne.*

B. Charæ hypogynæ, *A. Braun.*

6. Ch. Schweinitzii, *A. Braun.*—Subspecies of *Ch. coronata,* and very near *Ch. Braunii.*

α. longibracteata. = *Ch. foliolosa,* Schwein. (non Muhlenb.)

β. brevibracteata, condensata. = *Ch. foliolosa,* Un. Itin.

γ. brevibracteata, laxa. = *Ch. opaca,* Schwein. (non Agardh.)

Pennsylvania and Georgia, in many herbaria. This species appears to be generally mistaken in the United States for *Ch. foliolosa,* Muhl.; but in Willdenow's herbarium an entirely different plant, sent by Muhlenberg, is preserved under this name.

7. Ch. vulgaris, *Auct.*—Pennsylvania, Georgia, etc. in different varieties.

8. Ch. aspera, *Willd.*—Newfoundland, *La Pylaie.*

9. Ch. fragilis, *Desv.*—Newfoundland, *La Pylaie;* Pennsylvania? (*Schweinitz,* under his *Ch. opaca;* Georgia? (*Le Conte in herb. Zeyher,* mixed with *Chara vulgaris, Najas flexilis,* and the undescribed *Zanichellia cochlospermum,* A. Braun.

10. Ch. foliolosa, *Muhlenb. in Willd.,* can hardly be distinguished from the East Indian *Ch. Zeylanica,* belonging to the quite distinct group of *Gymnopodæ,* A. Braun.

11. Ch. Michauxii, *A. Braun.*—Ohio, *Michx.* and *Dr. Frank.* This belongs to the same group as the foregoing, and must be ranged together with it as subspecies, under the principal species *Ch. polyphylla,* A. Braun.

## Art. XIII.—*Catalogue of a collection of Plants made in Illinois and Missouri, by Charles A. Geyer; with critical remarks, &c.* by George Engelmann, M. D., of St. Louis.

Mr. Geyer, who is an excellent collector, is now absent on an expedition to the Rocky Mountains and Oregon, as announced in the last volume of this Journal, (p. 226.) Being unwilling to adopt the common plan of selling his collections to subscribers before they are actually made, he prefers to seek some needful aid in the prosecution of his arduous undertaking, by offering to the botanical public sets of the following plants, collected in 1842 near St. Louis, Missouri, and around Beardstown on the Illinois River. This collection (which is duly mentioned on p. 227 of Vol. xlv,) consists of the following species.

1. Ranunculus micranthus, Nutt. Apparently common in the grassy river bottoms, and on fertile grassy hills in Missouri and Illinois. It is very near *R. abortivus*, but apparently well distinguished by its pubescence, and the more orbicular, very seldom cordate or reniform lowest leaves.

2. Ranunculus fascicularis, Muhl.

3. Myosurus minimus, Linn. Certainly a native plant.*

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* We now ought to be careful observers of such plants as are apparently common to both continents: in after years it will be much more difficult to decide which are natives and which introduced. Many European plants, now common weeds east of the Alleghany Mountains, have not yet found their way to the Mississippi valley, but undoubtedly will arrive in a short time. Other plants are here already as common as they are in Europe, from whence they were derived, or in middle Asia, perhaps their original home. It behooves us therefore to note the progress of these intruders, and distinguish from them the true natives.

We are able to distinguish several different classes of such plants:

1. *Nearly allied geographical species*, where one takes the place of the other in the other continent; such as *Quercus alba* in North America, and *Q. pedunculata* in Europe; *Carpinus Americana* and *C. Betulus; Polygonum Persoonii* (n. sp. *P. mite*, Pers.) and *P. mite*, Schrank; *Androsace occidentalis* and *A. elongata; Lycopus sinuatus* and *L. Europæus*, and many others.

2. *Geographical varieties*, where no specific distinction can be discovered between the natives of both continents, but where the American and European variety can always be distinguished by some points of minor importance. Such are *Sium latifolium, Circæa lutetiana, Samolus Valerandi*, (if it does not belong to the first class,) *Castanea vesca, Lepidium ruderale, Astragalus hypoglottis, Eriophorum gracile, Myosurus minimus*, etc.

3. *Identical plants*, true natives of both continents, especially arctic or at least northern plants; also marine species and cryptogamic plants; e. g. *Potentilla an-*

4. Isopyrum biternatum, Torr. & Gr.

5. Delphinium tricorne, Michx.

6. Trautvetteria palmata, Fisch and Mey.; an entirely new locality for this rare plant, which has heretofore only been found in the Alleghany and Rocky Mountains.

7. Thalictrum anemonoides, Michx.

8. Brasenia peltata, Pursh.

9. Corydalis aurea, Willd.; the smaller, glaucous variety of the banks of the western rivers.

10. Cardamine Ludoviciana, Hook.

11. Cardamine hirsuta, Linn. δ. Virginica.

12. Sisymbrium canescens, Nutt.

13. Draba brachycarpa, Nutt.

14. Draba Caroliniana, Walt.

15. Lepidium Virginicum, Linn.

16. Polygala purpurea, Nutt.

17. Polygala incarnata, Linn.

18. Polygala verticillata, Linn.

19. Viola pedata, Linn.

20. Viola delphinifolia, Nutt.; common in rich prairie soil in Illinois and Missouri, where it does not take the place of *V. pedata*, as Nuttall intimates, but grows in the same region, though never on such poor clayey or gravelly soil as *V. pedata*.

21. Viola palmata, Linn., and

22. Viola sororia, Willd, are certainly nothing but varieties of *V. cucullata*, Ait.

23. Viola sagittata, Ait.

24. Viola striata, Ait.

25. Parnassia Caroliniana, Michx.

26. Hypericum sphærocarpum, Michx.

27. Hypericum Sarothra, Michx.

28. Anychia capillacea, Nutt.; well distinguished from *A. dichotoma*, Michx. by the smooth stem, the ovate or oblanceolate obtuse leaves of the branches, the pedunculate flowers, 1-nerved obtuse sepals, and twice as large seeds.

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*serina*, *Campanula rotundifolia*, *Epilobium spicatum*, *Cornus Suecica*, *Phragmites communis*, *Salicornia herbacea*, *Glaux maritima*, most *Equiseta*, etc.

4. *Naturalized plants*, spreading with the progress of civilization: of these we have in the neighborhood of St. Louis, *Taraxacum Dens-Leonis*, *Marrubium vulgare*, *Trifolium repens*, *Bromus secalinus*, *Verbascum Thapsus* and *V. Blattaria*, (perhaps belonging to the third class,) *Nepeta Cataria*, *Arctium minus*, etc. *Cichorium Intybus*, *Echium vulgare*, and others, I have not seen in the west.

It is difficult to decide to which of these classes *Datura Stramonium* and *Portulacca oleracea* should be referred. *Datura* is perhaps introduced in Europe as well as America, and possibly did not reach this country from Europe. *Erigeron Canadense* and *Œnothera biennis* are now as widely naturalized in Europe, as *Taraxacum* is in America.

29. Linum rigidum, Pursh.

30. Malva Houghtonii, Torr. & Gr. Intermediate between *Malva* and *Sphæralcea;* the carpels being 1-seeded as in Malva, but 2-valved as in Sphæralcea. The carpels separate mostly from the receptacle and from one another before opening.

31. Psoralea floribunda, Nutt.

32. Amorpha canescens, Nutt.

33. Petalostemon violaceum, Michx.

34. Astragalus trichocalyx, Nutt.? Probably a different species, but as I am unable to compare original specimens of Nuttall's plant, I am at present unable to decide. This species grows from a very strong fusiform ligneous root, in many cespitose stems, in the rich prairies and on grassy hills near St. Louis, (in Illinois,) and through the whole state of Missouri. It flowers in April and in beginning of May. The corolla is ochroleucous, with a bluish tip to the carina; the unripe legumes are succulent and edible, and when boiled resembling young beans in taste.

35. Desmodium sessilifolium, Torr. & Gr.

36. Lespedeza capitata, Michx.

37. Crotalaria sagittalis, Linn.

38. Spiræa lobata, Murr., and

39. Sanguisorba Canadensis, Linn. New localities for these plants, and probably the southern limit for them in the Mississippi valley.

40. Cratægus coccinea, Linn. var.? mollis, Torr. & Gr.

41. Cratægus tomentosa, Linn.

42. Rhexia Virginica, Linn.

43. Callitriche vernalis, Kützing, (in Linnæa, VII, 178.) One of the species of this genus common to America and Europe, and by most authors confounded with several others under the name of *C. verna*, Linn. It is well distinguished by the four angles of the small fruit being carinate; most other species having broadly winged angles and larger fruits.

44. Cicuta maculata, Linn.

45. Thaspium cordatum, Torr. & Gr.

46. Galium pilosum, Ait.

47. Spermacoce glabra, Michx.

48. Diodia teres, Walt.

49. Hedyotis minima, Torr. & Gr.

50. Hedyotis purpurea, var. Torr. & Gr.

51. Liatris cylindracea, Michx.

52. Liatris pycnostachya, Michx.

53. Aster sericeus, Vent.

54. Aster turbinellus, Lindl.

55. Aster azureus, Lindl.

56. Aster sagittifolius, Willd.

57. Aster multiflorus, Ait.
58. Aster dumosus, Linn.?
59. Aster miser, Linn.
    γ. diffusus, Torr. & Gr.
60. Aster simplex, Willd.
61. Aster carneus, Nees.
62. Aster puniceus, Linn.
    β. firmus, Nees.
63. Aster oblongifolius, Nutt.
64. Diplopappus linariifolius, Hook.
65. Diplopappus umbellatus, Torr. & Gr.
66. Solidago speciosa, Nutt.
67. Chrysopsis villosa, Nutt.
68. Silphium integrifolium, Michx.
69. Echinacea angustifolia, DC.
70. Helianthus occidentalis, Ridd.
71. Helianthus doronicoides, Lam.
72. Helianthus hirsutus, Raf.
73. Artemisia caudata, Michx.

73 *b*. Matricaria discoidea, DC. I have no doubt of this plant being a native here, and not introduced from Oregon or California, as Torrey and Gray (Flora, II, 413) suggest. It grows not only on wastes and roadsides near and even in St. Louis—(here it is found with *Maruta Cotula*, but flowers before this is six inches above ground)—but also four or five miles from the town, on grassy spots in the woods.

74. Hieracium Gronovii, Linn.
75. Lobelia leptostachya, A. DC.
76. Campanula aparinoides, Pursh.
77. Specularia perfoliata, A. DC.
78. Asclepias verticillata, Linn.
79. Asclepias incarnata, Linn.
80. Gentiana rubricaulis, Keat.
81. Gentiana ochroleuca, Willd.
82. Phlox glaberrima, Linn.

83. Cuscuta vulgivaga, Engelm. in Sill. Journ. XLIII, 338. C. Gronovii, Choisy. C. Americana, Auctor.

84. Cuscuta Cephalanthi, Engelm. Well distinguished by its small cylindric flowers, and by the corolla remaining on top of the capsule. It is found more on *Vernonia fasciculata* than on *Cephalanthus*. So far only found near St. Louis.

85. Lepidanche Compositarum, Engelm. So far only found in the prairies of Indiana, Illinois and Missouri. Cuscuta glomerata, Choisy.

86. Myosotis verna, Nutt.? If the description of *Myosotis verna* given in some American floras is correct, our plant cannot be the true *verna*. But as I have neither seen Nuttall's character, nor original specimens, nor eastern specimens at all, I must leave

this undecided. If our plant should prove distinct, I would suggest the name *M. inflexa*, adopted by me long since. I add the distinguishing characters of the European, the Western, and a nearly related Texan species.

*Myosotis stricta* (Link): calycibus profunde 5-fidis, laciniis subæqualibus linearibus obtusiusculis; calyce fructifero clauso; racemis basi foliatis; pedicellis fructiferis calyce brevioribus; tubo corollæ incluso; nucibus minimis.—*M. arvensis*, Reichenb., non Link, Lehm., Ehrh.

Europe.—Nuts grayish olive, very small, equal in size to the black nuts of *M. versicolor.*

*M. inflexa* (n. sp.): calycibus 5-fidis, laciniis calycis fructiferi erecto-conniventibus inæqualibus 2 inferioribus longioribus omnibus lanceolatis acutis albo-hispidis; racemis basi foliatis; pedicellis fructiferis calyce subbrevioribus basi erectis adpressis medio inflexis horizontalibus; tubo corollæ incluso; nucibus mediis *M. verna*, Nutt.?

Missouri and Illinois, dry prairies, open woods. April and May.—Annual or biennial? Calyx bilabiate; nuts twice as large as in the foregoing, of same color, equal in size to the black nuts of *M. intermedia*, Link.

*M. macrosperma* (n. sp.): calycibus 5-fidis, laciniis calycis fructiferi ovatis triangularibus acutis 2 inferioribus 3 superiores duplo superantibus, omnibus erecto-conniventibus flavo- s. ferrugineo-hispidissimis; racemis basi subfoliatis; pedicellis fructiferis calyce brevioribus basi adpressis; calycibus horizontalibus; tubo corollæ denique calyce longiore; nucibus maximis.

Texas, prairies, April. *F. Lindheimer.*—Nuts of same color as both others, but twice as large as those of the last, and larger than those of any European species examined by me; uncinate hairs of the calyx very long, stiff, spreading in all directions; flowers not so crowded as in both the foregoing species.

87. Phacelia Purshii, Buckley, in Sill. Journ. xlv, 171.

88. Physalis Pennsylvanica, Linn. Some of the specimens have smooth, and others pubescent or hairy calyces; these last ones constitute the *P. lanceolata*, Michx.

89. Pentstemon pubescens, Linn.
90. Collinsia verna, Nutt.
91. Gratiola aurea, Muhl.?
92. Hedeoma pulegioides, Pers.
93. Hedeoma hispida, Pursh.
94. Pycnanthemum pilosum. Nutt.

95. Monarda punctata, Linn.
96. Dracocephalon Virginianum, Linn.
97. Scutellaria galericulata, Linn.
98. Verbena paniculata, Lam. With undivided leaves, the true *V. paniculata;* and with the lower leaves divided, lobed or hastate, *V. hastata*, Linn., which can hardly be called even a variety. As Lamarck's name is equally applicable to both forms, it probably ought to be preferred to the Linnæan name.

99 to 102. Four hybrids of different species of Verbena, which together with several others that abound in this neighborhood, Mr. Geyer appears to have found equally abundant on the sandy wastes near Beardstown, and on the sandy islands of the Illinois River.

The names, chosen according to Schiede's proposition, indicate the parent plants; but it is often difficult enough to detect the parentage; indeed to ascertain which is the male and which the female parent is probably quite impossible if actual experiments be not instituted. Generally both parents grow near the hybrid, but as these Verbenæ are perennial, the hybrids, being unable to produce seed, propagate the more readily by stolons, and spread in some localities so as even to exceed one or the other of the parents in number. In such cases we have to rely entirely on the resemblance of the offspring to some true species in the vicinity. All these hybrids, however, are known to be such by their luxuriant growth exceeding that of their parents, by their sterility, and mostly by their local appearance in places where their parents are common. We find, as is naturally to be expected, many hybrids which resemble one of their parents more than the other; and hence many intermediate hybrid forms may be observed, so as to furnish all the connecting links between two very distinct species; this of course not proving the identity of such species, but rather the reverse. No hybrids are more common here than those between *V. stricta*, Vent. and *V. urticæfolia*, Linn., and I possess specimens not only of *V. urticæfolio-stricta*, (near *V. stricta*,) and of *V. stricto-urticæfolia*, (near *V. urticæfolia*,) but of several intermediate forms; the extremes of which might be taken for mere varieties of *V. stricta* and of *V. urticæfolia;* or they may be produced by seeds from these plants, adulterated by some pollen from the other species. The difficulty is increased by the fact that these doubtful hybrids produce more seeds than the nearly intermediate hybrids, though far less than the true species. In the course of time, if they propagate at all, they may revert again to their parental species, especially if the very probable supposition be true, that, when the ovary of these hybrids is fertile, the pollen is inert.

99. Verbena paniculato-stricta: more hirsute than *V. paniculata*, but not canescent like *V. stricta;* leaves much narrower than in *V. stricta*, subsessile or decurrent in a short petiole, simply or doubly or incisely serrate; spikes more crowded than in *V. paniculata*, more fascicled, not paniculate; calyces hairy, somewhat gray, longer than in *V. paniculata;* corolla intermediate in size and color, much paler than in *V. paniculata;* style persistent for some time on the ripening fruit, as in *V. paniculata.*

Grows in abundance on the sandy, sometimes overflowed, banks of the Mississippi, opposite St. Louis, with other hybrid forms, and with *V. stricta*, *V. urticæfolia*, and *V. bracteosa. V. paniculata* is very rare there, perhaps destroyed by the growing bushes, which now cover the formerly grassy spots. Nevertheless, the narrow leaves, deeper colored flowers, and persistent style, prove sufficiently that *V. paniculata* is one of its parents. Flowers in July and August.

100. Verbena urticæfolio-bracteosa: decumbent like *V. bracteosa*, but large, spreading sometimes two or three feet; leaves small, like *V. bracteosa*, laciniate; spikes fascicled, filiform; flowers distinct, as in *V. urticæfolia;* bracts longer than the calyx, but not more than half as large as in *V. bracteosa;* corolla larger than in *V. urticæfolia*, with a longer tube, very pale purple.

The parents of this hybrid cannot be mistaken; the growth, the leaves, the bracts of one, and the spikes, and the smaller size and paler color of the corolla of the other.

On sand-bars and sandy islands in the Mississippi (St. Louis) and Illinois rivers, (Beardstown.) Flowers July to September.

101. Verbena stricto-urticæfolia: an interesting hybrid between two very distinct species. The plant is more canescent than *V. urticæfolia;* the leaves shorter petioled, sometimes nearly sessile, of firmer texture, and not simply serrate, but generally doubly or even incisely serrate; sometimes even so much incised or lobed that I would have been inclined to look to *V. hastata* or *V. bracteosa* for an explanation, but we cannot admit the action of three species in the formation of hybrids. The spikes are filiform, the

flowers compacter than in *V. urticæfolia*, but not as densely imbricated as in *V. stricta* or *V. paniculata;* the calyx much longer than in *V. urticæfolia*, canescently hairy; corolla large, intermediate in size between both parents, and pale purple.

This is the most abundant hybrid here, and both parents are amongst the most common weeds about St. Louis. Flowers in July and August.

102. Verbena urticæfolio-paniculata: leaves petioled, lanceolate, with simple, double, or sometimes incised serratures, generally elongated; spikes thin, more properly filiform than in any of our species; calyx and corolla intermediate in shape, size, and color, between both parents. It resembles some varieties of the true *V. paniculata*, but the dark purple flowers, and the thick cylindric fruiting spikes, at once distinguish it.

St. Louis and Beardstown; grassy places and open woods. July and August.

Besides these four hybrids, I have found here the corresponding ones more nearly resembling the other parent, which I designate by the same names, reversing the order, viz.

*Verbena stricto-paniculata:* greener, narrower, more petioled leaves, darker flowers, than *V. paniculato-stricta.*

*V. bracteoso-urticæfolia:* adscendent, with large lobed leaves, and thinner spikes.

*V. urticæfolio-stricta:* canescent, with sessile leaves, and thin filiform spikes.

*V. paniculato-urticæfolia:* with broader leaves, thinner spikes, paler and smaller flowers.

Then there is the *V. angustifolio-stricta* and *V. stricto-angustifolia.* Hybrids of *V. angustifolia* with any but *V. stricta*, and of *V. bracteosa* with any but *V. urticæfolia*, or of *V. Aubletia*, the only remaining species in this region, I have not yet found. The only other hybrid found by me in this country, is *Rumex obtusifolio-crispus.* Whether these introduced plants hybridize in their native country is unknown to me.

103. Androsace occidentalis, Pursh.
104. Lysimachia revoluta, Nutt.
105. Plantago cordata, Lam.
106. Polygonum tenue, Michx.
107. Polygonum sagittatum, Linn.
108. Croton glandulosus, Linn.
109. Borya ligustrina, Willd.
110. Quercus nigra, Willd.
111. Quercus alba, Linn.
112. Quercus castanea, Muhl.

113. Salix Muhlenbergiana, Willd.
114. Salix nigra, Marsh.
115. Salix longifolia, Muhl.
116. Salix rigida, Muhl.?

117. Potamogeton diversifolius, Barton, β. spicatus. This form appears at first view to be a distinct species, characterized by the narrower, only 5-nerved upper leaves, and petioled oval or cylindric spikes. *P. diversifolius*, α. *capitatus*, the common form, has more oval 7-nerved upper leaves, and nearly sessile few-flowered heads. But sometimes the lower heads of our variety are also capitate and nearly sessile, and the fruit is generally alike. The fruit, or nut, is always compressed, winged on the back, with two lateral carinæ, which are generally denticulate, the nut appearing muricate; and in β. they are often nearly or entirely undivided, but by no means generally so. The embryo describes 1½ of a spiral circumvolution; the embryo of most other species forms only ¾, 1 or 1¼ circumvolution. I know but one species, *P. densus*, which exhibits 2½ circumvolutions.

It may not be amiss here to remind botanists in this country, that the ripe fruit furnishes the best characteristic marks to distinguish the different species of Potamogeton. The fruit, for example, proves that *P. marinus*, Linn. is entirely distinct from *P. pectinatus*, Linn., with which most authors confound it; *P. marinus* occurs not only on the sea-coast, but also in the salt-ponds of the Upper Missouri, (Geyer, in Nicollet's expedition.) Specimens of Potamogeton should always be collected with ripe fruit.

118. Phalangium esculentum, Nutt.
119. Trillium recurvatum, Beck.
120. Juncus marginatus, Rostk.
121. Dulichium spathaceum, Pers.
122. Cyperus kyllingæoides, Vahl.
123. Isolepis capillaris, Rœm. & Schult.
124. Heleocharis tenuis, Schult.

125. Eriophorum gracile, Koch, in Roth. catalect. 2. p. 259. A species which has frequently been found in the United States; it appears to have been taken for *E. angustifolium*—my specimens at least, received from Pennsylvania and from Ohio, were so labelled—but is easily distinguished by its triquetrous, subulate leaves, and the linear yellowish seeds. The true *E. angustifolium*, Roth, is the largest of all the species, with the longest (1½ inch) wool; leaves 1 or 1½ lines broad, channeled; pedun-

cles smooth. *E. latifolium*, Hoppe, (*E. polystachyum*, Auct.) has flat leaves and scabrous peduncles; and both have obovate, dark or light brown seeds.

I propose the following disposition of these species, acknowledging however that I have studied the American varieties from dried specimens only, never having observed any living ones.

*E. latifolium* (Hoppe): culmo trigono, foliis planis apice triquetris, spiculis plurimis, pedunculis scabris, nucibus obovatis. *E. polystachyum*, β. Linn.

α. *nigro-carinatum:* squamis floriferis plumbeis, carina nigricante, nucibus acutiusculis brunneis. Germany; probably throughout Europe.

β. *viridi-carinatum:* squamis floriferis obscuris, carina virescente, nucibus obtusis, lutescentibus. Massachusetts, Ohio.

*E. angustifolium* (Roth): culmo teretiusculo, foliis canaliculatis apice triquetris, spiculis pluribus, pedunculis lævibus, nucibus oblanceolatis acutis. *E. polystachyum*, α. Linn.

Squamæ floriferæ nigro-carinatæ, albo-marginatæ. Europe. I have not seen any American specimens.

*E. gracile* (Koch): culmo obsolete trigono, foliis triquetris, spiculis pluribus, pedunculis scabris, nucibus linearibus (flavicantibus). *E. polystachyum*, γ. Linn. *E. triquetrum*, Hoppe.

α. *plurinervium:* pedunculis tomentoso-scabris, squamis floriferis pallidis, nervis pluribus pallidioribus striatis, nucibus obtusiusculis. Germany.

β. *paucinervium:* pedunculis scabris, squamis floriferis pallidis, nervis paucis (3) pallidioribus notatis, nucibus acutis. Illinois, Ohio, Pennsylvania.

126. Carex rosea, Schk.
127. Carex multiflora, Muhl.
128. Carex arida, Torr. & Schw.
129. Carex cristata, Torr. & Schw.
130. Carex Willdenovii, Schk.
131. Carex Torreyana, Dew.
132. Carex Shortii, Torr.
133. Carex laxiflora, Lam.?
133. Carex Meadii, Dew. in Sill. Journ. Vol. XLIII, p. 90.
135. Carex umbellata, Schk.
136. Panicum virgatum, Linn.
137. Panicum pubescens, Lam.
138. Panicum scoparium, Lam.
139. Panicum clandestinum, Linn.
140. Digitaria filiformis, Ell., var. floribus majoribus.
141. Aristida stricta, Michx.
142. Melica speciosa, Muhl.?
143. Festuca nutans, Willd.
144. Diarrhena Americana, Pal. de Beauv.

145. Atheropogon apludoides, Muhl.

146. Atheropogon papillosus (n. sp.): culmis cæspitosis basi foliatis; foliis lanceolato-linearibus planis margine et ad nervum medianum infra supraque ex papillis serrato-ciliatis; spicis 1–3 subterminalibus biserialibus unilateralibus multifloris; glumis papilloso-hispidis; valva corollæ perfectæ exteriore trifida, valva corollæ neutrius brevissima hyalina ex basi triaristata.

Sandy soil, Beardstown, Ill.—Very near *A. oligostachyus*, Nutt., and resembling it closely, but distinct by the broader and hispid (not setaceous and smooth) leaves, the hispid (not pubescent) glumes, and the hyaline glume of the abortive floret (not half as large as in *A. oligostachyus.*)

147. Andropogon scoparius, Michx.

148. Poa hirsuta, Michx.

149. Poa pectinacea, Michx.?

149, *b.* Hordeum pusillum, Nutt.

150. Woodsia Perriniana, Hook.

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Art. XIV.—*On the Mode of Formation of the Tails of Comets;* by William A. Norton, Professor of Mathematics and Natural Philosophy in Delaware College.

It is not my design, in the present article, to furnish a complete theory of the process by which the tails of comets are formed from their heads. This cannot be attempted, it is presumed, with any reasonable hope of success, until more facts relative to the structure and phenomena of comets have been accumulated. But little more will now be undertaken, than to disprove the commonly received notion that the tail and head of a comet form one connected mass, revolving as one body, and to establish the opposing doctrine, that the tail is made up of particles of matter continually in the act of flowing away from the head. To do this intelligibly and effectually, however, it will first be necessary to treat briefly of the

### *Physical Constitution of Comets.*

What I have to offer upon this preliminary topic, may be conveniently arranged under the following heads; viz. 1. The nature of comets. 2. Their structure. 3. Their variations in form and dimensions.

1. *The nature of Comets.*—It is well known that it has long been considered an established fact in astronomical science, that the cometary bodies are collections of matter which is far more subtil in its texture than the lightest gas, or the most evanescent vapor. There are visionary theorists, however, who, not content with the mere shadow of materiality which astronomers have attributed to these bodies, deny them the honors of material existence altogether, seeing in them nothing but fortuitous images. And there are men of science, who with Appian and Tycho Brahe, of old, while they conceive the head to be a real corporeity, maintain that the tail is a mere spectre of light. This latter theory has, it must be allowed, at the first glance, an air of great plausibility; as it is remarkably simple in its conception, and seems to give a ready explanation of the more familiar phenomena. But it would be easy to show that it does not stand the test of comparison with facts, when attentively applied. It would be a work of supererogation, however, to attempt this in the present communication, as there is no evidence that this theory has secured any foothold in the region of true science. I shall accordingly take it to be an admitted fact that the tail of a comet, as well as its head, is a material substance.

Judging from appearances, there is, moreover, no distinction of kind in the matter of which comets are composed. All parts of a comet shine with the same nebulous light, with the exception only of the nucleus; and this often assumes a similar appearance, when viewed through a telescope. If any further evidence be wanted of an identity of nature in the matter of the nucleus and of other parts of the comet, we may find it in the undoubted fact that the nebulous envelope of the head receives frequent supplies from the nucleus. It is not to be overlooked, although, that all this evidence really applies, at least directly, only to the outer parts of the nucleus. The central portions, for any direct proof to the contrary that we have, may be regarded as unchangeably solid, as they have been by Schrœter and some other astronomers. But the existence of comets with very small nuclei and of others with no nucleus at all, furnishes a strong presumption, in confirmation of the natural inference from what is above stated, that the whole nucleus is composed of the same species of nebulous matter as the other portions of the comet.

The tail, though generally less bright than the nebulosity of the head, is not always so; e. g. the comet of 1843, as seen on the 28th of February.*

Whether comets are self-luminous or shine by reflected light, is a question which, though it has been much discussed, is not yet settled. Since the evidence of a reflection of light, sought for in phases of the nucleus and in signs of polarization in the light received from a comet, has not been found sufficient to establish its existence, Arago proposes another method of research in the case, founded upon observed variations in the intensity of the light, which may perhaps be more successful.

2. *The structure of Comets.*—A cometary body is composed of two connected portions of nebulous matter, called, respectively, the head and the tail. The head consists, in general, of a central nucleus, (although having a greater lustre, composed as we have seen reason to believe, of the same species of matter as the other parts, but in a more condensed state,) enveloped on the side towards the sun, and ordinarily at a greater distance from its surface in comparison with its own dimensions, by a globular nebulous mass, called the *nebulosity.* This, it is said, never completely surrounds the nucleus, except in the case of comets which have no tails. It in fact encircles only that hemisphere of the nucleus which is turned towards the sun. The tail begins where the nebulosity terminates, and seems, in general, to be merely the continuation of this in nearly a straight line beyond the nucleus. There is, ordinarily, a distinct space containing but little luminous matter between the nucleus and the nebulosity, but this is not always the case. From the accounts that have been given of the telescopic appearances of the comet of 1843, it would seem that the nucleus and nebulosity of this comet were seldom visibly separate; what is there called the nucleus, being in fact the nebulosity and nucleus combined. The tail of a comet has the shape of a hollow frustum of a cone, with its smaller base in the nebulosity of the head; with this difference, however, that the sides are usually more or less curved, instead of being straight. They are, in general, concave towards each other, as in the case of the recent

* See American Almanac for 1844, p. 94.

comet as seen on the 28th of February; sometimes perhaps convex. The whole tail is generally bent, so as to be concave towards the regions of space which the comet has just left. This curvature is most perceptible near the extremity of the tail, and has in one instance (that of the comet of 1744) been observed to be as great as 70° or 80°. The envelope of the head is not a hemisphere, but approximates to the form of a hyperboloid, having the nucleus in its focus, and its vertex turned towards the sun. In some instances the nucleus is furnished with several envelopes concentric with it; and sometimes each of these is provided with a tail. Each of these several tails lying one within the other, being hollow, may in consequence appear so faint along its middle as to have the aspect of two distinct tails. A comet that has in reality three separate tails, might thus appear to be supplied with six, as was the comet of 1744. If the different envelopes were not distinctly separate from each other, then we should have all the tails appearing to proceed from the same nebulous mass.

3. *Variations in the form and dimensions of Comets.*—It is well known that both the head and tail of a comet are subject to great changes in their apparent dimensions, and frequently some slight changes of form, during the period of its visibility, which have an obvious relation to the distance of the comet from the sun. These changes cannot be attributed to the variations in the amount of light received from the sun; for, in the first place, they are too irregular, and, in the next place, the length of the tail, as well as the intrinsic lustre of the whole comet, continue to increase until some time after the perihelion passage. The nebulous envelope of the head moreover, increases in its dimensions as the comet departs from the sun. It follows, therefore, that a comet is not a body of invariable size, like the planets, and that the tail is actually formed out of a portion of the matter of the head, as it appears to be; and this by the operation of some cause whose action depends upon the distance of the head from the sun.

Such are most of the facts appertaining to the physical constitution of the cometary bodies which will be employed in the discussion upon which I propose to enter. Their importance in the present connection, must be my apology for occupying the pages of a Journal of Science with the recital of facts, for the most part, long since established.

*Mode of Formation of the Tails of Comets.*

To proceed with due caution, in approaching the field of inquiry before us, we must seek for some solid ground to advance upon. This may be found in the following statements. 1. The general situation of the tail of a comet with respect to the sun, shows that the sun is concerned, directly or indirectly, in its formation. We have seen too, that the changes which take place in the dimensions of a comet, both in approaching the sun and receding from him, conduct to the same inference. 2. Since the tail lies in the direction of the radius-vector prolonged beyond the head, the particles of matter of which it is made up, must have been driven off from the head by some force exerted in a direction from the sun. 3. This force cannot emanate from the nucleus, for such a force would expel the nebulous matter surrounding the nucleus in all directions, instead of one direction only. This objection, it is true, would be obviated, if a repulsive action were to be exerted by the nucleus only, from that hemisphere which is on the side opposite to the sun; but it will be at once perceived that such a force as this would not give the tail the form and direction which it is known to have, when it is considered that the tail has its origin in the nebulosity at the side of the nucleus. A repulsion from the nebulosity is also out of the question, as, on this supposition, the matter would be expelled outwards in all directions. In fact no one force having its origin in the head of the comet, can be conceived of, that would be adequate to the production of the tail. A tangential force at first view, might seem to be, but this would only form a tail proceeding from one side of the nucleus. The idea of two or more tangential forces can hardly be entertained, as, besides its inherent improbability, it involves the idea of matter in different states, or of different kinds in different parts of the tail, for which we have not the least shadow of evidence. It is possible however, as we shall see farther on, that a repulsive action of the nucleus upon the matter of the nebulosity, may be combined with some other force foreign to the comet, as an auxiliary cause in producing the phenomena of the tail—its effects on the side towards the sun being contracted, at a certain distance from the nucleus, by this latter force.* 4. There seems, then, to be little room to doubt

* Although, as I have asserted in the context, there is no one force immediately related to the nucleus that can form the tail, it is perhaps possible to conceive of

that the matter of the tail is driven off from the head by some force foreign to the comet, and taking effect from the sun outwards. 5. This force, whatever may be its nature, extends far beyond the earth's orbit. For comets have been seen provided with tails of great length, though their perihelion distances exceeded the radius of the earth's orbit, (e. g. the great comet of 1811.) Nothing can be predicated with certainty with respect to the law of variation of this force, but it is at least probable, that, like all known central forces, it varies inversely as the square of the distance.

I do not now propose to discuss the question of the nature of this force by which cometic matter is expelled in a direction opposite to the sun—that is, whether it consists in an impulsive action of the sun's rays, as Euler imagined, or in a repulsion by the mass of the sun, operating at a distance, as supposed by Olbers and Bessel. I would only remark, that as experiment has failed to discover any impulsive force in the sun's light, the choice must be given to that one of the two views which best explains the phenomena. Whatever may be the nature of the force in question, I will call it *the repulsive force of the sun.* Granting its existence, there are two modes in which we may conceive it to operate in forming the tail. We may suppose that it drives off the nebulous matter to greater and greater distances, without destroying the connection of the parts; so that the tail and the head will always be revolving as one connected mass. Or we may conceive that it is continually detaching portions of the nebulosity, and repelling them to an indefinite distance into free space. The first mentioned conception is the theory which has been in vogue hitherto. But it seems to me that there are good and sufficient reasons for rejecting it, and adopting the other in its stead. These it will be my object now to give.

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two such forces adequate to its production. Thus, we might imagine a very rapid flow of the more elevated portions of the nebulous matter from the hemisphere turned towards the sun around to that which is turned away from him, by the mere effect of heat and cold, and that, on reaching this hemisphere, the particles are driven off by the action of a repulsive pole. Something of the same sort might be conceived to be in operation on the earth. Thus we might imagine some subtil fluid flowing from the equator, and accumulating about the poles, and subsequently expelled in detached portions by the repulsion of the magnetic poles, forming the streamers of the aurora borealis and aurora australis; but to such speculations there is no end.

1. There appears to be no satisfactory reason to be assigned why the force which expels the nebulous matter to the end of the tail should not urge it still farther. Let us take the case of the comet of last year. The extremity of its tail was, at one time, at about the same distance from the sun as was the nucleus of the great comet of 1811, a while after its perihelion passage; when it had a bright tail more than a hundred millions miles in length. The force that was sufficient to expel such a quantity of nebulous matter from this latter comet, ought it not to have driven still farther the much rarer matter at the remote parts of the visible tail of the comet of 1843? A resisting medium might give a limitation to the velocity of flow, but could not destroy it altogether.

2. In the case of the comet of last year, the repulsive force of the sun, which, by the theory in question, is supposed to keep the tail continually opposite to the sun, or nearly so, could not have been of sufficient intensity to do this, without materially deranging the orbit. If this cannot be proved to a mathematical certainty, it can, at least, be rendered highly probable; as I will now proceed to show.

If the head and tail of a comet revolve together as one mass, it must be the centre of gravity of this mass that describes the parabolic orbit; and moreover, since the tail keeps continually opposite to the sun, this mass must rotate about its centre of gravity, at the same rate that the centre revolves around the sun. If the tail be conceived to fall somewhat back of the line of the radius-vector prolonged, as it does in point of fact, then, it may chance that the sun's repulsive actions upon the varying parts of the comet may give a resultant, having its line of direction so situated, behind the centre of gravity, as to tend to produce the rotation required. If we could find the situation of this resultant, for any assumed inclination of the tail to the radius-vector, produced beyond the orbit, as well as the expression for the moment of inertia of the whole mass divided by the mass, then, as the angular velocity of rotation would be known at each point of the orbit, being the same as that of revolution, we might, by a well known formula of mechanics, easily compute the velocity of translation that would be given to the centre of gravity of the rotating mass by a force of sufficient intensity to produce the rotation. Afterwards it would be easy to find whether this velocity would carry the body to a perceptible distance from the parabolic orbit. These calculations cannot, however, be made with any pretension to accuracy, for want of the requisite data. Still we can make such suppositions as will almost infallibly give a result less than the truth, which will serve our present purpose equally well. Let us suppose, then, the comet to be at its perihelion, and with the view of making the computation above referred to, seek for some safe conclusion as to the length of the tail at that point.

In solving this inquiry, the first consideration that I would present, is that the apparent length of the tail gives no certain indication of its actual length. This is manifestly true when the comet is seen in the day time, as was the recent comet on the 28th of February, for, we know that the part of the tail near the head, when a comet is seen at night, is in general brighter than the other parts. That we never see all of the actual tail, even at night, may be inferred from the fact that the apparent length is very different as seen from different places. For example, it is said that "the tail of the comet of 1759, appeared at Paris to be only 2° or 3° in length; but at Montpelier 25°. The comet of 1769 at Paris seemed to have a tail 60° long; but at Boulogne 70°; and at the Isle of Bourbon 97°." The same inference may be drawn from the circumstance that the light diminishes gradually, from the head to the extremity of the apparent tail. In fact, certain observations made upon the recent comet seem to show, that the actual quantity of matter in a section perpendicular to the axis, was about the same at the extreme end of the tail as in the vicinity of the head. Thus, on the evening of the 11th of March, this comet was barely discernible at this place, ten minutes after the three stars in Orion's belt came distinctly into view, which would make its brightness about equal to that of a star of the third magnitude. That it was not greater than this is evident from the fact that the tail was less bright than the nucleus, which had about the same lustre as the star Zeta Ceti, of the third magnitude. It was observed also that the extremity of the tail was about twice as broad as the most luminous part of it, which was not far from one sixth of the length distant from the nucleus: and I find that the ratio of the distances of these parts from the earth, was very nearly as 3 to 2. From which it appears that the tail was three times broader at its extremity than at the part which gave the most light. This result may be tested by a comparison with the results of other observations. Thus, the breadth of the tail at its extremity, on the same evening, was estimated to be a little less than 3°. Taking it at 3°, I find the actual breadth to have been 7,040,000 miles. Now according to Mr. Caldecott, of the Royal Observatory at Trevandrum, the nebulosity several days after the perihelion passage was 20,000 miles in diameter; and Prof. Bartlett, of the U. S. Military Academy, found its diameter to be nearly 40,000 miles, on the 29th of March. Taking either one of these numbers for the diameter on the 11th of March, we find the point of the tail at which the breadth was one third of that of the end, to be very nearly at the distance of one third of the length of the tail, from the head—within $\frac{1}{350}$ of this length if the first number be used. The inclination of the sides of the tail, on the 3d of March, as determined by Piazzi Smyth, Esq., of the Royal Observatory at the Cape of Good Hope, and corrected for the obliquity under which the angle was viewed, furnishes a similar result for that date. It would seem therefore that the variation of breadth must have been at least as great as the estimate on the 11th of March would make it. This being allowed, I remark that this increase of breadth in the proportion of 1 to 3, if we suppose the quantity of matter to have been the same in each section, ought to have made the light at the extremity three times less, provided there had been no variation in the inclination of the line of sight to the line of the tail. The variation in this angle which actually obtained, reduces the ratio just given to 2.44. This supposes however that the quantity of light emitted, varies only with the density of the cometic matter. But, if we adopt the theory most in vogue, that comets receive their light from the sun, there must be an increase of this ratio in the proportion of 4 to 1. We thus obtain as the final result 9.76. Now we have seen that the brightest portion of the tail gave about as much light as a star of the third magnitude. To compare this intensity of light with that at the extremity, it is only necessary to observe that, the moon being little past her first quarter on the evening of the 11th of March, stars of the fifth magnitude were scarcely, if at all discernible, and then to employ the experimental comparisons of the light of the stars, obtained by Sir William Herschel. In this way we find the ratio of intensities to have been as 1 to 4. Some allowance however, should be made for the light intercepted by the atmosphere, which was the greatest at the lowest of the two points considered. It is believed that doubling the ratio just found will suffice for this. This being done we obtain for the actual ratio, 1 to 8, which corresponds very nearly with the ratio computed on the supposition of the existence of an uniformity in the absolute quantity of matter. The observations of the 28th of February, seem also to be in accordance with this supposition. The comet was seen on that day in the immediate vicinity of this place by a very intelligent individual, who informs me that the head was a little smaller than the sun, (certainly not larger,) and that the tail was as much as three times broader, at its extremity, than at the head. The whole comet is described as being similar in form to an ox-bow or the letter U, only that the branches were more divergent—the sky appearing even darker between them than any where else. The observations at Woodstock, Vt., make the variation of breadth a little greater, if we assume the size of the head to have been only $\frac{1}{2}^{\circ}$. It must certainly have been less than $1^{\circ}$, as there was a very marked divergence in the sides of the tail, and the average breadth was not estimated by any of the observers higher than $1^{\circ}$. Agreeably to our supposition, therefore, there must have been a decrease of light, from one end of the comet to the other, in the ratio of 3 to 1; and, if we conceive the light to be derived from the sun, it will become as 12 to 1—which is about the ratio of the quantity of light given by a star of the third, and one of the fifth magnitude, or by stars respectively of the first magnitude and intermediate between the third and fourth. It is moreover quite as great as the observations themselves would seem to warrant us in supposing.*

* The phenomena of the disappearance of the great comet of 1843, as seen in the vicinity of this place (Newark, Del.) on Feb. 28th, are not a little curious. The comet was first noticed at from 9½ to 10 A. M. After having remained visible for about three quarters of an hour, during the latter half-hour of which interval it was almost constantly watched by my informant, in a situation in which the eye was completely protected from the sun, it suddenly began to disappear at the extreme points, without there being any perceptible haziness in the atmosphere. The branches continued to shorten, and in a few minutes were entirely wanting. The comet had now assumed the appearance of a round ball, and glowed with a more intense lustre than before. This latter fact is particularly insisted on. This round ball gradually contracted until it became a mere bright point, and then disappeared—producing the impression that it was moving away into the depths of space. These facts, as well as those mentioned in the context, came accidentally

It appears, therefore, that the most probable conception, to say the least, that can be formed of the distribution of matter in the tail of the recent comet, is that there was the same quantity of matter in each section perpendicular to its axis. And if this conception be in accordance with fact, (in case we have regard only to the absolute quantity of matter, and not to the density, which is all that calculation to be made requires,) it is plain that the tail may, so far as we know, have extended to a vastly greater distance than it appeared to do. As to its probable apparent length at the perihelion, had it been seen in the evening, the lengths observed after this date, in connection with the history of previous comets, would make it, at least, 25,000,000 miles. If it be admitted that the tail was seen by Mr. Walker, at Philadelphia, on the 23d of February, (who represents it to have extended 30° in the heavens,) it must have been more than 50,000,000 miles in length at that date. In view of all these considerations it would seem that we might safely take the actual length of the tail at the perihelion as great as 50,000,000 miles. After having made the calculation upon this supposition it will be easy to determine the effect upon our results of any supposed diminution in the length. In fact, it will be seen that the principal conclusions arrived at cannot be overthrown by any changes, that are at all admissible, in the two hypotheses in respect to the length of the tail and the distribution of its matter, that have been adopted.

Another requisite datum, in the calculation, is the proportion between the quantities of matter in the head and tail of the comet. It appears that the nucleus, as seen by the different observers had not the appearance of being a solid. Amici of Florence, who saw the comet on Feb. 28th, compares the whole mass, without making any distinction between the nucleus and the tail, to "a flame:" and Mr. Clarke of Portland, compares its appearance on the same day, to "a white cloud of great density." Other accounts convey a similar idea. Mr. Clarke also represents the nucleus to have been no brighter than the tail. From his account and Amici's, it may certainly be inferred that there was no mate-

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to my knowledge some three months after the date at which the comet was seen; and so much time was afterwards consumed in the endeavor to identify the date that it was concluded to defer their publication to the present time. I have found it impossible to fix upon the day with positive certainty: but a collection of all the circumstances, leaves little room to doubt that it was the 28th of February. [The true date is probably the 27th; for, the comet was certainly seen on the 28th as late as 3 P. M.: see this Journal, Vols. XLIV, 412: XLV, 230.—EDS.]

rial difference between the brilliancy of the nucleus and that of the nebulosity and of the parts of the tail nearest the head. According to the determinations of Mr. Caldecott, as Prof. Peirce informs us, the diameter of the nucleus several days after the perihelion passage was 5,000 miles. (At this time the nucleus shone with a stronger lustre than the tail, and generally, indeed, after the 28th of February.) Judging, then, from the appearance of the comet on Feb. 28th, and the relative size of the head and tail, we should infer that there was less matter in the former than in the latter. Mr. Walker also quotes the great astronomer, Bessel, as saying "this comet seems to have expended the greater part of its nucleus in building up its splendid tail." This statement was made on the 28th of March. Whatever may have been the actual length of the tail at the time of the perihelion passage, it cannot be doubted that it received considerable accessions of matter afterwards. It is to be observed, however, that the increase in the length of tail seen, is in fact attributable to the increased obliquity under which it was viewed in receding from the earth. Taking all that has now been stated into account, it would seem to be a large allowance to regard the nucleus and nebulosity as containing a thousand times more matter than the tail.

Now let $w=$ the angular velocity of rotation, that is, the space passed over in the unit of time (one second) by a point at the unit of distance (one mile); $v=$velocity of translation of centre of gravity; $p=$ arm of lever of the resultant of all the forces of rotation acting upon the various parts of the comet; and $k^2=$ moment of inertia with respect to the centre of gravity of the whole mass of the comet, divided by the mass; then we have, from mechanics, $v=\frac{k^2w}{p}$, (1). We will first find the value of $k^2$. Whatever may be the breadth of the tail, and whatever its precise form, its moment of inertia will be diminished by supposing all the particles to approach its axis. (I conceive, for reasons already given, each section of the tail to contain the same quantity of matter.) It is therefore allowable to imagine the whole mass of the tail to be condensed upon the axis, so as to form one heavy line of uniform density. The middle of this line will be the centre of gravity of the tail. Let $x=$ distance of any point of this line from the centre of gravity; $l=$ half the length of the tail; $m=$ moment of inertia of any portion of the tail, and $m'=$ moment of inertia of the whole tail; then, $m=\int x^2\times dx=\frac{x^3}{3}+c$. Integrating between the limits $x=0$, and $x=l$, we have $\frac{m'}{2}=\frac{l^3}{3}$, and $m'=2\cdot\frac{l^3}{3}$, (2). As we are ignorant of the dimensions of the head at the time of the perihelion passage, for which the calculation is to be made, we will neglect its moment of inertia with respect to its centre, which on any admissible supposition is but a very small fraction of the moment of inertia of the tail, and will, so far as it has any effect, only make $v$, the velocity of translation, the greater. $2l=$ mass of the tail; and $1000\times 2l+2l=1001\times 2l=$ whole mass. Put $b=$ distance of centre of gravity of whole mass from centre of nucleus, and $a=$ distance of same point from the centre of gravity of tail. ($b=$ 24,975 miles $=$ 25,000 miles (nearly); $a=$24,975,025 miles.) Also let $M=$ moment of inertia of whole mass—neglecting as above. Then, by the principles of mechanics, $M=2\cdot\frac{l^3}{3}+2l\times a^2+(1000\times 2l)b^2$: and $k^2=\frac{2\cdot\frac{l^3}{3}+2l\times a^2+(1000\times 2l)b^2}{1001\times 2l}=\frac{\frac{l^2}{3}+a^3+1000b^2}{1001}$, (3). Making the calculation we obtain $k^2=$ 831,876,980,528.

Next, to find $w$, I take the formula for a parabolic orbit, $t=D^{\frac{3}{2}}\sqrt{\frac{2}{m}}\,(\text{tang.}\tfrac{1}{2}u+\tfrac{1}{3}\,\text{tang.}^3\tfrac{1}{2}u)$, (4); in which $t=$ time elapsed since the instant of the comet's arrival at its perihelion, or a certain interval before; $u=$ anomaly corresponding to the time $t$; $D=$ perihelion distance; and $m=$ intensity of sun's attraction at the unit of distance. Taking $1=$ radius of earth's orbit, and one day for the unit of time, $m=0.00030$; $D=0.005263$ ($=$500,000 miles): and making $u=90°$, $t=$ one hour (very nearly). But, as there is some uncertainty in the perihelion distance, we will take $t=1\frac{1}{2}$ hours, or $2t=3$ hours. During this interval of three hours, in which the comet passed from 90° on one side of the perihelion to 90° on the other side, the average angular velocity of revolution was 0.000291 of a mile per second. Equation (4) gives 0.00066 of a mile for the angular velocity at the perihelion, little more than twice the average velocity. But as the tail probably fell back somewhat while the comet was passing around the sun, we will take the angular velocity of rotation at the perihelion no greater than 0.000291 of a mile, the average velocity above given. It cannot have been much less than this, for if we suppose it to have been one half less, then, while the motion of revolution in the interval $2t$ was 180°, that of rotation would have been only 45°, and thus the tail would have been nearly perpendicular to the radius vector when the comet was at its perihelion, and have fallen far within the orbit an hour and a half afterwards, which is opposed to all analogies. The velocity really taken makes the deviation at the latter date as much as 90°.

Now, substituting the values of $w$ and $k^2$ in equa. (1), we get $v = \frac{242,076,201}{p}$, (5). It still remains to find the value of $p$. Supposing that the sun's repulsive force takes effect only upon the tail, and is the same in the same angular space, which is the case with all central emanations, so far as known; also that the deviation of the tail from the position of opposition to the sun is 45°, the resultant of the sun's actions will bisect the angle subtended by the tail, and will act with an arm of lever equal to 188,110 miles. For a deviation of 90° the leverage will be nearly twice as great. It will be seen farther on, that the supposition that the repulsive force keeps the tail continually opposite to the sun, requires that this force should vary more rapidly than central forces in general, which would make the arm of lever still less. The value of $p$, just found, being substituted in equation (5), we obtain, finally, $v = 1287$ miles. This is the velocity of translation due to an instantaneous force of impulsion acting with the above arm of lever, and of such intensity as to give a velocity of rotation equal to the average velocity of revolution during the period of three hours employed by the comet in passing immediately around the sun. It would also be the velocity due to the supposed repulsion of the sun acting up to the time of the perihelion passage, if this had always retained the same direction.* But as it did not, we have now to seek

* The arm of lever would be very nearly the same in the different positions of the comet, for the same length of tail and the same deviation. The change of length of the tail may be neglected.

for the effect of its change of direction. For greater simplicity, let us confine our attention to the hour and a half immediately preceding the perihelion passage. In this interval three fourths of the angular velocity of rotation which obtains at the perihelion is received, and thus three fourths, or nearly so, of the velocity of rotation at the same point. We will, in the first place, conceive the force to act continually with its average intensity, and, at the same time, the motion of revolution to be uniform at its average rate; then, the resultant of the increments of velocity imparted in the different instants of the interval considered, will be to the sum of these same increments as the chord of $90^\circ$ is to the quadrantal arc, as $\sqrt{2}$ to 1.5708, as 0.89 to 1, and it will be inclined $45^\circ$ to the axis of the parabolic orbit. Next, to solve the actual case, we must seek for the law of variation of the supposed repulsive force of the sun. Let the force in question be denoted by $\varphi$, and we have $\varphi = \frac{dv}{dt}$. Now the motion of rotation is constantly the same as that of revolution, and thus the angular velocity of rotation $= v = \frac{1}{r^2}$. Hence $dv = -\frac{2dr}{r^3}$. We also have, from the parabolic orbit, $dt = \frac{-rdr}{\sqrt{2m(r-D)}}$, (the time being reckoned from the aphelion.) Whence $\varphi = \frac{2dr\sqrt{2m(r-D)}}{r^3 \times rdr}$ $= \sqrt{8m} \,.\, \frac{\sqrt{r-D}}{r^4}$. We learn from this expression that the force $\varphi$ equals zero at the perihelion, and attains to its maximum value, $41\frac{1}{2}^\circ$ from the perihelion, where $r = \frac{8}{7}D$: also that the variation of its intensity is according to a more rapid law than that of the inverse squares. It will be seen, therefore, that its entire effect during the hour and a half which immediately precedes the instant when the comet is at its perihelion, is greater than the approximate value of this, found above, and is in pretty nearly the same direction. We may therefore make use of the approximate value instead of the true, in seeking for the effect in double the interval just mentioned, as the result will be less. Multiplying then the value of $v$ which has been found by 0.89 and by $\sqrt{2}$, we obtain the quantity sought; viz. $v = 1214$ miles (per second) in the direction of the axis, outwards from the orbit. The subsequent action of the force will only slightly diminish this velocity. Now $\frac{1}{60}$ of a mile would give in twenty days an apparent displacement in the plane of the orbit of about half a minute of an arc, which is more than the difference between the observations and the best ephemeris. From which it appears, that if the force necessary to keep up the rotation were to be diminished more than seventy thousand times, its effect upon the orbit ought still to have been perceptible.

If we were to suppose the tail to have been only 4,000,000 miles long, while the comet was nearest the sun, which is not much more than half its length, as seen in the day time on the 28th of February, then the velocity found as above, would be about one hundred and fifty times less; which would still be about four hundred and seventy times too great. To reduce it as low as is necessary we must then suppose, farther, that there was four hundred and seventy times more matter in the head of the comet.

If we imagine, as some astronomers have done, the only bond of connection between the different parts of the comet to be that of gravitation, the force will have to be the same, and it will have the same effect upon the motion of the centre of gravity.

There is another mode in which the supposed entire connected mass of a comet may be conceived to be set in rotation, besides that which we have been considering, viz. by the action of the excess of the sun's attraction for the nearer over that for the more remote parts of the comet. Let us attempt its investigation. It will be observed that this force cannot alter the orbit, and that the only inquiry will be whether it is of sufficient intensity to produce the known rate of rotation. Now let G = resultant of the differences between the sun's actions upon the various points of the tail, and his action upon the extremity supposed distributed over the whole length; Y = distance of point of application of this force from the sun; $g$ = sun's force of attraction at the unit of distance; D = distance of nucleus from the sun; $d$ = distance of extremity of tail; and $x$ = distance of any point in the tail: then, $\int \frac{g}{x^2} . xdx$ = sum of moments of forces soliciting the different particles; and $\int \frac{g}{d^2} . xdx$ = sum of moments of forces equal to force at the extremity of the tail. This being the case, we may proceed with the investigation as follows; GY =

$\int\frac{g}{x^2}\cdot xdx-\int\frac{g}{d^2}\cdot xdx=g\log.x-\frac{g}{d^2}\cdot\frac{x^2}{2}+\text{C}.$ $\text{C}=-g\log.\text{D}+\frac{g}{d^2}\cdot\frac{\text{D}^2}{2}$; whence $\text{GY}=g\log.\frac{x}{\text{D}}-\frac{g}{d^2}\cdot\frac{x^2}{2}+\frac{g}{d^2}\cdot\frac{\text{D}^2}{2}$. Integrating between the limits $x=\text{D}$, and $x=d$, we have, $\text{GY}=g\log.\frac{d}{\text{D}}-\frac{g}{d^2}\cdot\frac{d^2}{2}+\frac{g}{d^2}\cdot\frac{\text{D}^2}{2}=g\log.\frac{d}{\text{D}}-\frac{g}{2}+\frac{g}{2}\cdot\frac{\text{D}^2}{d^2}$ and $\text{Y}=\frac{g}{\text{G}}\cdot\log.\frac{d}{\text{D}}-\frac{1}{2}\cdot\frac{g}{\text{G}}+\frac{1}{2}\cdot\frac{g}{\text{G}}\cdot\frac{\text{D}^2}{d^2}$, (6). Now to find G; $\text{G}=\int\frac{g}{x^2}\,dx-\int\frac{g}{d^2}\,dx=-\frac{g}{x}-\frac{g}{d^2}\,x+\text{C}$; and $\text{C}=\frac{g}{\text{D}}+\frac{g}{d^2}\text{D}$. Substituting and integrating between the limits $x=\text{D}$, and $x=d$, we obtain $\text{G}=\frac{g}{\text{D}}-\frac{g}{d}+\frac{g}{d^2}\text{D}-\frac{g}{d^2}d$, (7). Hence $\text{Y}=\dfrac{g\log.\frac{d}{\text{D}}-\frac{1}{2}g+\frac{1}{2}g\frac{\text{D}^2}{d^2}}{\frac{g}{\text{D}}-\frac{g}{d}+\frac{g}{d^2}\text{D}-\frac{g}{d^2}d}=\dfrac{\log.\frac{d}{\text{D}}+\frac{1}{2}\frac{\text{D}^2}{d^2}-\frac{1}{2}}{\frac{1}{\text{D}}-\frac{1}{d}+\frac{\text{D}}{d^2}-\frac{1}{d}}$, (8). Making the calculation for the perihelion, (taking the perihelion distance $=1$,) we get $\text{Y}=4.19183=2{,}095{,}915$ miles. Equation (7) gives $\text{G}=0.989g$; $g$=weight of unit of length of tail at the unit of distance. Now we find that the sun's attraction for the head exceeds that for the tail in the ratio of 102,042 to 1: thus, dividing Y – 500,000 miles in this ratio, we have for the distance of the point of application of sun's force from the centre of the nucleus, 15.6 miles. The distance of this point from the centre of gravity will then be 24,975 – 15=24,960 miles. Assuming the deviation of the tail from the line of the radius-vector to be as great as 45°, the arm of lever of the force will then be 17,652 miles. Substituting this for $p$ in equation (5), we get $v=13{,}713$ miles. Three fourths of this, or 10,284 miles, will then be the velocity of translation due to a force acting with the above mentioned arm of lever, continually in the same direction, and of sufficient intensity to impart the additional velocity of rotation received during the hour and a half which immediately precedes the perihelion passage. Now, to obtain the velocity due to such a force acting after the same manner as the sun; I find, by calculation, that the portion of the latter force which acts upon the tail is about one half less 90° from the perihelion. Since, however, this is only from the $\frac{1}{50000}$ to the $\frac{1}{100000}$ part of the force acting upon the head in the different positions, the law of variation of the whole attraction considered, will not sensibly differ from that of the accelerating force of the comet in its orbitual motion. The arm of lever will also remain very nearly the same. Thus, proceeding as on page 117, we shall have an approximate value of the velocity sought, viz. 9,153 miles. Multiplying by $\sqrt{2}$, we find for the velocity in the interval of three hours 12,943 miles (nearly). The average intensity of the accelerating force of the comet in this interval (=0.08614 miles per second) is very nearly the same as that of the force producing the rotation. In three hours this latter force, acting in the varying direction of the radius-vector, will then generate a velocity of 584 miles per second. Whence it appears that it is twenty two times smaller than the force requisite to produce the rotation. But it is to be observed that it would be more correct in the present case to take the true interval answering to the anomaly 90°, as calculated on page 116; which is one hour, instead of one hour and a half. If this be done, the sun's force will be found to be fifty times too small. This result, it will be recollected, answers to the supposition that the tail had a length of 50,000,000 miles at the perihelion. If we suppose its length to have been only 10,000,000 miles, the force of the sun will then be only ten times too small; and a length of 5,000,000 miles will make it six times too small. This deficiency may be made to disappear by supposing the quantity of matter in the head to be about six times greater, or six thousand times more than in the tail. I conclude, therefore, that if the head and tail of a comet revolve and rotate as one connected mass, the force which generates the rotation is the attractive instead of the repulsive power of the sun; for any supposition that will reconcile the observations upon the comet of 1843 with the action of a repulsion, will more than suffice to make the attraction great enough to produce the rotation. But it will be observed that a discussion of the observations upon this comet, in connection with the history of comets in general, has led to the adoption of elements quite different from those which the sun's attraction, considered as the cause of the rotation, requires.

3. Whichever of the two forces that have now been under consideration be conceived to be in action, there would seem to be certain almost inevitable results flowing from their action which are opposed to observation. The first that I would notice

is, that whenever a comet, which has its perihelion near the sun, (as the comets of 1843 and 1680,) sweeps around the sun, the great centrifugal force generated by the amazing velocity of rotation would entirely dissipate the greater part of the tail. It may be well to remark, in this connection, that the supposed rotation of a comet would, in general, dissipate the tail more or less rapidly, unless the particles should be held together by a strong molecular attraction. For, I find, that taking the mass of the head as great as the $\frac{1}{10000}$ part of the mass of the earth, and supposing the rate of rotation to be only 2° per day, the centrifugal force will be equal to the gravitation towards the head at the distance of only 39,000 miles. In the case of the comet of last year, this equality subsisted, at the time of the perihelion passage, at the very small distance of 434 miles from the centre of the nucleus. These examples will serve to show, that on the theory now under consideration the centrifugal force must be supposed to play an important part in the elongation of the tail. Another of the consequences of this theory at variance with observation is, that the velocity of rotation communicated in the approach to the sun, being still retained after the passage of the perihelion, and being continually augmented by the action of the force which is the operative cause of the rotation; when the tail comes up into opposition, it ought soon to get in advance of this position, and more and more from day to day until the velocity of rotation becomes reduced to an equality with that of revolution, by the action of the force on the other side of the centre of gravity. Other considerations might be urged corroborative of the evidence already obtained of the fallacy of the common notion that all the parts of a comet are united into one revolving and rotating mass; but it is time that I proceeded to give a more detailed exposition of the other conception to which I referred in the beginning of this article, and to furnish such direct arguments in support of it as my limits will admit.

The theory that cometic matter continually flowing away from the head of a comet constitutes what is called the tail, first occurred to me while preparing an article on the subject of the recent comet, subsequently published in the Philadelphia Inquirer of April 25th: and it is there given, in its incipient state, as a mere suggestion—the intimation being at the same time given that, although new to the writer, it had, in all probability, previously occurred to some of the numerous theorists who had speculated upon the mysteries of the luminous appendages of comets. A communication setting it forth with some degree of detail, and offering some arguments in support of it, together with others against the view of the matter generally entertained, was afterwards read before the American Philosophical Society at the celebration of the hundredth anniversary of the Society in May last; a brief abstract of which has since been published in the account of the proceedings had on that occasion. Circumstances beyond my control had hitherto prevented me from making such examinations of astronomical works as to satisfy myself whether the conception which I had formed of the tails of comets was altogether new, and I, accordingly, did not, on this occasion, present any claim to be the originator of it. I have since found that it is a feature of Olbers' more complete theory, as modified by Bessel.* With the fact that Olbers conceived a portion of the matter of the nucleus to be driven off by a repulsion residing in the nucleus I had long been acquainted, but no explanation of the theory that I had met with, represented it as conceiving matter to be flowing off continually to an indefinite distance. Most of the theories that have been promulgated, contemplate the matter of which the tail consists, as having been expelled from the head by some force taking effect in a direction from the sun. There was nothing in the mere assertion of a new operative force to suggest the idea of a perpetual emission, such that there should be at no time any physical bond of connection between the head and tail of the comet; any more than there had been in the assertion of other forces having the same general tendency. I have made this brief historical statement, that it might not be supposed that I had on any occasion urged unfounded claims to priority of discovery. I now proceed to the consideration of the matter in hand; and will begin with a more precise and detailed explanation of the theory. First, then, I conceive that the tail of a comet is made up of particles of matter continually flowing away at a very rapid rate from the head into free space, and that at any one instant we see the collection of all the particles that have been emitted during a certain previous interval. According to this, at the end of any such interval we are looking at an entirely

* For the outline of this theory, see Vol. XLV, p. 188, of this Journal.

new tail. The particles may be supposed to be detached from the outer parts of the nebulosity by the sun's repulsive force, so called; in which case they would fly off in the directions of the lines diverging from the sun, along which the force acts, but would be made by the attraction of the nucleus to pursue paths somewhat, though doubtless slightly deviating from these lines, and concave towards the axis of the tail; or, we may imagine them, as Olbers and Bessel have done, to undergo some modification by the action of the sun, by reason of which they are first repelled outward from the nucleus, and then driven away from the sun into the depths of space by his superior repulsion. According to this view of the matter, they acquire an initial velocity in leaving the nucleus, and subsequently, under the action of the sun's repulsive force, supposed to vary according to the law of the inverse squares, they will move off in hyperbolas, having the sun in their remote focus, and concave towards the axis of the tail. This, or an equivalent fact, has been established by Olbers, and I find may be easily shown by introducing into the investigation of the ordinary case of central forces the modifications consequent upon the supposition that the two components of the accelerating force are positive instead of negative. These hyperbolic paths will be changed more or less by the continued repulsive action of the nucleus. Combined with these motions with respect to the nucleus, there will be the orbitual motion which each particle had at the instant of leaving the head, which will be retained afterwards. The effect of both these motions will be to make each particle describe a hyperbola having the sun in its remote focus. For, the particle may be conceived to start from a point of the orbit, or near the orbit, with an initial velocity equal and parallel to the velocity in the orbit, or equal to this modified in amount and direction by the repulsion of the nucleus, according as one or the other of the two views that have been given of the mode of disengagement of the particles be taken, and afterwards to be repelled by the sun. (I here regard the repulsive action of the nucleus as having no other effect than to impart a certain projectile velocity, in a moderate distance.) It is to be observed, too, that the motion with respect to the nucleus will be modified by the change in the direction and velocity of the nucleus subsequent to the escape of the particles. Also, if the two motions just mentioned be contemplated as subsisting together, the motion relative to the head will obviously be somewhat different from what it otherwise would be, in consequence of the change of direction of the sun's force produced by the orbitual motion.

Making use of certain data mentioned in a former part of this article, I find that the sides of the tail of the recent comet diverged from each other on the third of March, as if they came from a point but little more than 100,000 miles from the head. The comet of 1744 presents a case of still greater divergence. If, therefore, the matter of which the tail is made up be supposed to be detached from the marginal parts of the nebulosity by the repulsive force of the sun, there must sometimes, if not always, be some cause in operation tending to increase the divergence of the sides of the tail due to the separation of the lines of direction of the force. This can apparently be found in a rotation of the head. The effect of such a rotation would be to make the particles revolve around the axis of the tail, at the same time that they are darting along in the direction of its length, and thus to recede continually from the axis; as there would be but a small quantity of matter within their orbits to oppose by its attraction the centrifugal force consequent upon the motion of revolution. But is there any evidence of a rotation? To this question I make answer, that in the first place, since all the other heavenly bodies, so far as known, have this species of motion, there is a fair presumption that the cometary bodies have it likewise. In the next place, certain observed changes in the relative position of the multiple tails of some comets, and of the sides of the single tail of others, have rendered it almost certain that the tails of some of these bodies had a rapid rotation about their axes. The comets of 1769, 1811, and 1825, may be cited as examples. A rotatory motion of Halley's comet at its last appearance in 1835, was inferred from the rapid changes noticed in the situation of certain luminous streams, in the form of circular sectors, seen to issue from the nucleus on the side towards the sun. The observations upon the recent comet made at the Cape of Good Hope, (see Amer. Almanac for 1844, p. 95,) would seem to indicate the existence of the same motion in the tail, or rather tails, of this comet also. To produce a revolution of the particles of the tail around the axis, it is not necessary that the head should rotate about the prolongation of this line. Nor is it necessary that there should be a rotatory motion in the plane of the orbit, so as to keep the first equator constantly in the same situation with respect to the radius-vector. Any change in this situation would only alter the rate of revolution and consequently the degree of divergence of the sides of the tail, the laws of the variation of which are not known. Still, if such a motion be supposed to subsist, we have an explanation in the centrifugal force of the first mentioned rotation, (in case its axis lies nearly in the plane of the orbits,) of the fact of the closer proximity of the nucleus to the nebulosity on the side towards the sun: and Bessel has, in point of fact, seen reason to infer its existence in the case of Halley's comet in 1835.*

As to the variation in the velocity with which a particle flows off into space, it is evident that the tendency of the force must be to make the velocity increase continually, but more rapidly at first than afterwards. It will be seen too, that, whether we suppose the nucleus to have a repulsion for the matter that is moving away from it or not, the variation of the velocity at any considerable distance must be mainly due to the repulsive power of the sun. But if it be a fact that the matter which enters into the constitution of the tail, is, for a considerable portion of the length uniformly distributed, as we have seen reason to suppose was the case, or very nearly the case with the comet of 1843, then the particles must soon attain to a maximum velocity, and continue afterwards to move on at the same rate. This might nearly happen in case of a very rapid reduction of the force; but the more probable conception would be that the limitation to the velocity was an effect of the resistance of an ether in space. Such a resistance would, however, afterwards diminish the velocity as the force decreased, (though in a less rapid ratio,) unless the density of the ether decreased at the same rate that the force did.

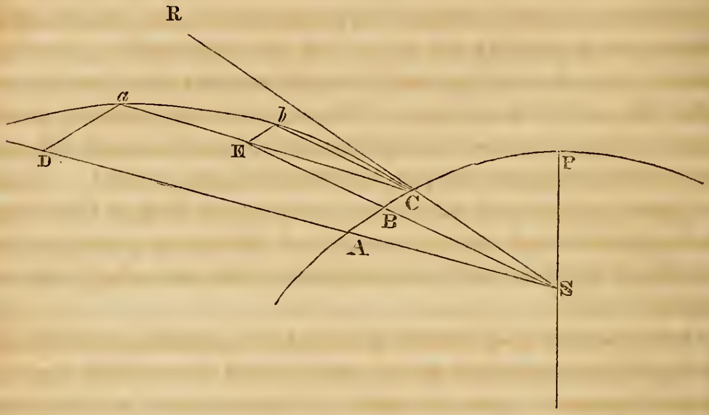
I conceive that the tail terminates, to us, when from the increase of its tenuity in consequence of the divergence of the sides and of the augmentation of the velocity of the flowing particles, (and from the increase in the distance from the sun, if this luminary is the source of the light of the comet,) its light becomes too feeble sensibly to affect our eyes. It augments in brightness

* See Vol. XLV, p. 206, of this Journal. The greater divergence of the sides of the tail than of the lines of direction of the sun's force, and the form of the nebulosity, are natural consequences of Olbers' theory of a repulsion from the nucleus.

and apparent length, when the supply of emitted matter is in greater quantities than before in a given time. Whether we suppose, with Herschel and others, that the materials of the tail are furnished by the heat of the sun, or, with Olbers and Bessel, that the particles of the tail flow directly from the nucleus, under the operation of a repulsion consequent upon some polarizing action of the sun, it must increase in apparent length and brightness as the comet approaches the sun. But it is supposable, on either theory, that the maximum action may not be till a certain time after the perihelion passage. The tail may also undergo variations of brightness and of length, as seen from the earth, by reason of changes in the obliquity under which it is viewed. Thus, the great brilliancy of the recent comet on the 28th of February, and its great length in the latter part of March, are partially attributable to the small angle of inclination of the line of sight to the line of the tail.

As to multiple tails they may originate in separate nebulosities, or may be collections of matter upon which the nucleus has different degrees of repulsive action. The fact often noticed, that multiple tails spring up suddenly and generally soon disappear, (of which we had an exemplification in the comet of 1843, as seen about the 3d of March,) may be alluded to here as affording striking evidence of the truth of the theory under consideration; for, it will be seen that their disappearance is a simple consequence of the waste of the local stock of materials which in the act of escaping had formed the supernumerary tail.

There is but little space left for the explanation of phenomena. Let us first see how the theoretical agrees with the actual situation of the tail. Let PCA be a portion of a comet's orbit, the sun being at S: and suppose a particle to be expelled in the direction SAD, when the head is at A, and another particle to be driven off in the direction SBE, when the head is at B. Each particle will retain the orbitual motion which obtained at the time of its departure, as it moves away from the sun; and thus, when the comet has reached the point C, instead of being at any points D and E on the lines SAD and SBE, will be respectively at certain points *a* and *b* farther forward. The line C*ab*, which when the comet is at C, is the locus of all the particles that have been emitted during the interval of time in which the comet has been moving over the arc AC, is the tail. It is easy to see that this must be a curved line concave towards the regions of space which the comet has left. Supposing the arc AC to be so small, or its curvature to be so slight that it may be considered as a straight line, and neglecting the change of the velocity in the orbit, C*a* will be parallel to AD, and C*b* parallel to BE, whence RC*a*= CSA, and RC*b*=CSB. Thus the line joining any particle with




the nucleus always makes an angle with the prolongation of the radius-vector, equal to the motion in anomaly during the interval that has elapsed since the particle left the head. It follows from this that, if we suppose the velocity of the particles to be continually the same, and the motion in anomaly to be uniform, the deviations of the particles *a* and *b* from the line of the radius-vector will be in the ratio of the distances C*a* and C*b*. But in point of fact, the velocity increases with the distance, so that the curvature of the tail will be less than on the supposition just made: and, we may suppose, may after a certain time, come to be so great, compared with the velocity in the orbit, as to make the rest of the tail almost perfectly straight, as the greater part of it is sometimes observed to be. A curvature may afterwards spring up at the extremity in consequence of the nebulous matter being there more retarded by the resistance of the ether which is believed to pervade all space—this resistance having a greater effect than before, because of the diminution of the sun's force, and, perhaps, of a diminution in the density of the cometic matter itself. As to the amount of the deviation of the tail from the line of the radius-vector, it must depend upon the proportion between the velocities of the particles, and the velocity of the head in its orbit:

and it follows from the principle just established, that unless the velocities of emission augment as rapidly as the velocity of revolution, the deviation in question will increase to the perihelion and afterwards decrease; as it is in fact known to do. It appears therefore that the theory explains the general phenomenon of the situation of the tail.

We see also, in the light of this theory, why it is that the nebulosity is confined to the side of the nucleus that is turned towards the sun. All portions of nebulous matter that may at any time chance to be on the other side are soon expelled. As the sun does not act upon the farther side of the nucleus, there is probably little if any matter ever rising from that side.

The comparative indistinctness, sometimes noticed, of the following side of the tail may arise from the fact that the sun has acted during a shorter period of time upon that side of the nucleus.

I will only remark farther, that it is no objection to the theory which I have been advocating, that, if it be true, comets must be wasting away by reason of the continual escape of the matter of which they are composed, during each period of their approach to the sun. For observation has long since led astronomers to believe that such a waste is in actual progress. In fact there is nothing to forbid our supposing that the faint telescopic comet which steals through our firmament, almost unobserved, was once a very prince in the skies, and gloried in as long a train as did our illustrious celestial visitor of 1843.

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Art. XV.—*Reply to Mr. Couthouy's Vindication against the charge of Plagiarism;* by James D. Dana, Geologist of the United States Exploring Expedition.

We cannot but regret that it has become necessary to intrude so unpleasant a controversy, as that before us, on public attention, and I should take my part in it with extreme reluctance, were it not urgently required, as well by the interests of science as of truth. If possible, I would now gladly drop the subject, especially because of its bearing upon Mr. Couthouy's character: but this may not be. No ill will towards Mr. Couthouy instigated the charge at Albany, but solely a regard for right; much of the friendly feeling that sprung up while abroad, still lingered about me, and I couched my reclamation in as few words as possible—simple and courteous, but decided. The same course I shall still pursue in the remarks which follow; a plain and concise statement of facts will be sufficient I trust to set the subject at rest. Mr. Couthouy's paraphrase of my charge—which, by the way, merits a second reading, as a very explicit exposition of the crime of plagiarism—evinces sufficiently that he himself will appreciate the facts, thus stated, as fully as if expressed with vituperative language.

The public have cause for regret that Mr. C. did not bring forward at once the abstract of his journal sent home from Sydney, which is said to contain the views in dispute; as many words might possibly have been saved, if the facts are as stated; and it would have borne down with more force than all his dozen pages of argument. But for some reason this was kept behind. A few particulars respecting this abstract might be added here, but are better reserved until some personal accusations are disposed of.

Mr. Couthouy complains of unfairness in my not addressing him before making the charge public, and dwells upon the intimacy between us at sea, in order to bring out in bolder colors this "misused confidence." I acknowledge fully the "peculiar intimacy," and remember well the "warm expressions of regard" with which we parted when leaving the Sandwich Islands. I could bring farther evidence on this point if necessary, but will only desire the reader, before perusing the following remarks, to turn again to the last two pages of Mr. Couthouy's vindication. The confidence was mutual, evinced equally by each in endeavors to give aid in our several departments; and Mr. Couthouy never before, till his late Reply, accused me of failing to return his kindness—of giving him three or four dozen specimens for his three or four hundred—a fact (if we double the three or four dozen) it is true, but only so because Mr. C. was not with us at the Feejees to receive the contributions made by me to his departments, and left us for home at the Sandwich Islands before I had opportunity to return the kindness which he was enabled to bestow by his arrival at that group so long before they were reached by the squadron.* The *acknowledged* inti-

* Mr. Couthouy was with the squadron only about *one year and a half* of the *four* occupied in the cruise.

macy and confidence will set aside any imputation on my fidelity to him while abroad.

This intimacy and confidence continued, as he states, to the last. It led me, on arriving from the Feejees, to lay before him my Report alluded to, and my coral drawings, the latter including the coral animals of more than one hundred species. The Report, so strangely forgotten, extended over *seventy written pages*, and occupied us nearly *six hours* in reading. After presenting him all my ideas and showing him the drawings, I proposed, (in view of what I had done in this branch of science—the zoological part of which belonged rightly to him, and the geological to me,*) that we should unite our labors and bring out a report together on the whole subject of corals; and from the kindness with which the suggestion was received, I believed it to be a settled agreement between us. Soon after this, Mr. Couthouy was detached from the squadron, and, before finally separating, the proposition was again talked over, and the importance discussed of his making observations in the West Indies, towards the joint report. We parted "with warm expressions of regard."

From this time, I heard nothing from Mr. Couthouy, till the arrival of the squadron in '42. Within a few hours after landing, I was told that he had published an article on coral islands. I was disappointed, as I at once recalled the understanding with which we separated; but, as may be imagined, I was afterwards not a little astonished to hear that he had advanced certain views in the same, respecting the influence of temperature on their distribution; for in all our discussions abroad, notwithstanding our confidence, he had never intimated to me that this idea occurred to him till suggested in my Report. I waited, with the hope that some friendly word from Mr. C. would greet my return, or that a copy of his coral publication would be sent to me, or, if none were on hand, that a few lines at least, in allusion to it, would be mailed for a friend so intimate. But notwithstanding the "peculiar intimacy" between us, and the "warm expressions of regard" with which we parted, and the understanding that we were to coöperate in our report on corals, not a syllable was received. I wait-

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* Mr. C. claims in his vindication that the whole subject of corals was in his hands, much to my surprise, and no doubt to the surprise of all, who know that the structure of coral islands is so far a *geological* question as to constitute an important chapter in all geological treatises. The point was considered so far settled at sea as never to have been mooted.

ed for ten months yet heard nothing—a long silence, which seemed to betoken a consciousness of having done me wrong. Was it then obligatory on me, after an exhibition of *such* warm feelings of regard, *such* friendship, to address him on the subject? I went to Albany with the expectation of meeting him there, and making my reclamation in his presence; but as he was absent, I had no alternative left but to make my statements before a body who were well acquainted with his writings.

Where then was the breach of faith and honor—and on whose part the misused confidence? I would have welcomed him on my return with warm greetings as when we parted. But afterwards, I could not but lose some portion of my esteem on finding that in violation of an implied agreement he had published on corals,—that he had published too the very views read to him from my report, and moreover that he showed not common courtesy, much less the friendship professed, in neglecting to acquaint me with his publication. And what shall we say of the honorable feeling which, besides violating such obligations, could trespass also on the department of a friend, for he has given to the public numerous geological facts observed abroad besides those on coral islands? What of the honesty which could find any excuse for transmitting home, duplicate minutes of his journal, contrary to express prohibition by the authority under which we sailed?

With regard to my "imaginative brain," attributing opinions never expressed by him respecting a limiting temperature, let us take out the paragraph from the cloud with which he has obscured it in his vindication, and permit it to speak for itself. It reads thus:

"It is my belief that, to a certain extent, the corals are limited in their range of growth by temperature rather than depth, and that wherever this is not below 76° F., there, *cæteris paribus*, they will be found to flourish as in the Polynesian seas; accordingly we find that their principal formations are placed within the tropics, and though I have no means of ascertaining at this moment the fact, I apprehend that in the Indian Ocean, as in the Pacific, the Saxigenous polypes will be found most abundant and at their greatest depths in a belt comprising about twenty degrees on each side of the equator."—(Boston Journal of Natural History, Vol. IV, p. 76.)

It requires no lawyer's skill to make out that the words above, imply that 76° F. is a limiting temperature. I so understood it, most honestly; and such is the obvious idea to be gathered from the paragraph. However, a writer sometimes uses words by mistake that do not express the idea intended, and such may have been the fact in the case before us, although there might be some reason for doubt, seeing that *he gives no instance of a temperature below* 76° *in any of the coral seas.* Mr. Couthouy would have us understand that 76° F. is not given as the *limiting* temperature, but the *flourishing* temperature, and that where the temperature is not below 76° F., corals will flourish, "as in the Polynesian seas:" or, as he states in another place, that "where that exists (76° F.) '*is the field of their most lavish display.*'" But how does Mr. C. arrive at the fact that 76° is the most congenial temperature? On what accurate and extended series of observations is this important deduction based?

He states that through the coral archipelago to the eastward of Tahiti, the surface temperature ranges from 78° to 81°, (Bost. Jour. p. 75.) The fact is that the range is from 77° to 83°, and in the second part of his article printed at a later period, we find this range given, (p. 100,) evidently a correction of the former from subsequent information, and not a part of his expedition observations.

He says that the same is true "of the neighborhood of the detached islets between Tahiti and Samoa." The correct range for this region is from 75° to 81°.

He states that at Tutuila in the Samoa group, the surface temperature was 81°, and that at the bottom, in thirteen fathoms, where the coral was growing profusely, was 76°: and adds, with reference to this supposed fact and the others adduced, "that I here intend to prove, that as throughout the archipelago, where corals flourish in such perfection, the surface temperature is the same as at the reef off Tutuila, so also is the temperature of the bottom, i. e. 76°, is surely obvious, even without what here follows;" after which he quotes the paragraph above cited, with some additional facts which we notice below.

With regard to the surface temperature at Tutuila, it ranges from 75° to 82°; and as to 76° being the temperature at the bottom in thirteen fathoms where corals were growing,* it is, as

* By referring to the log-book of the Vincennes, I find that *no temperature* was taken at *any depth* on the reef here referred to. The *thirteen fathoms* was obtained by a cast alongside of the reef; the reef itself on which the coral is growing varies in depth from 4½ to 7 fathoms. (See Expedition charts, now publishing.)

a general truth, which he is disposed to make it, wholly erroneous; and is not even correct for the Samoa group, except it may be at some particular season of the year. When the surface temperature is 75°, the temperature at a depth of thirteen fathoms will be much below this.

Mr. Couthouy states that at the Sandwich Islands the temperature "is as high sometimes as 81°," but strangely neglects to add that *it is as low sometimes as* 68° F. This be it remembered, is "in the Polynesian seas," (see the paragraph cited on a preceding page.)

In view of so many errors and hasty conclusions, is it not most charitable to suppose that Mr. C. never made any observations with reference to this subject? for I know his zeal too well to believe without good evidence, that he would otherwise have been so superficial and inaccurate. But supposing his facts true, what do they prove? That 76° is the flourishing temperature, or as he expresses his belief on page 384, Vol. XLV, of this Journal, that wherever this temperature of 76° exists, there corals will be found to flourish in the utmost profusion? Why not as well 77°, or 78°, or 79°, or 80°? All the temperatures given, are above 76°, and it would be the most probable conclusion from them, that if there is a flourishing temperature, it is the mean of the whole, or 79½°.

Perhaps however he wishes his more general assertion received, instead of the one here dwelt upon, namely, that where the temperature is not below 76°, there they will flourish *as in the Polynesian seas.* But we will not tire the reader with needless words. I merely add, that on the coast of New Caledonia, in latitude 20°, where coral reefs are so extensive, the temperature falls at certain seasons to 73°. 69° was the average for the month of February at the Sandwich Islands, (*one of the Polynesian groups,*) as obtained by the Exploring Expedition. A writer states that near the Bermudas in 1837, the temperature of the sea in December fell to 67½°. The General Report on the temperature of the ocean by Capt. Wilkes, will throw much light on this subject, and we now leave it, as my readers are probably fully satisfied, that whether Mr. Couthouy intended to give 76° as the *limiting* or *flourishing* temperature, he is in something of an error.

I would not say that 76° is *not* the temperature best suited for corals. I advance no opinion on the subject. It requires more investigation than has yet been bestowed upon it to arrive at any conclusion, and surely more facts and truer facts, than are brought forward by Mr. Couthouy. It might be determined possibly in a group like the Feejees by observing, with marks attached to different species, the rate of growth in summer and in winter, or at the surface, and in the colder water of the bottom. It will probably be found that some species prefer the hot water of 80° or higher, while others increase most rapidly at 71° or 72°, or perhaps at even a lower temperature. The range of temperature is all that I pretend to have arrived at. On leaving the Feejees, by comparing my results with such other information as I could then obtain, I set the lowest limit, in my manuscript, at 70°, to be corrected after farther investigation. The Sandwich Islands reduced the limit to 68°, and additional facts have lowered it to 66°.

An instance of equivocation is very apparent in the unfortunate sentence to which we have alluded on a preceding page.—He is quoting from his Boston article to prove that he there made 76° F. the flourishing temperature, and brings in the clause referred to, "where that exists (76° F.) '*is the field of their most lavish display.*'" (p. 385.)—But in the Boston Journal, this *field of their most lavish display*, has very different limits. On page 160 it reads, "among the Paumotus, the field of their most lavish display, the temperature varies from 77° to 83°." The change in the idea is most unfortunate, as the original is less objectionable. We may reasonably hesitate before we give full credit to the statements of one who will so prove false to his own writings.

I was led into error by a friend, with regard to Mr. Couthouy's views having been presented to the Geological Association at Boston: but this matters little with the point at issue.

My readers are probably satisfied that I have not "misused confidence," nor exhibited "any thing like an approach to unfairness," nor attributed to Mr. C. "imaginary statements," "fictitious facts," opinions never expressed, direct from my "imaginative brain," and that there is *more* than "one syllable of truth" in my plea, with nothing of that "gross and inexcusable misrepresentation" which is to stamp me as guilty of "behavior the most dishonorable."

I might dwell upon the admission by Mr. C. that the fact of the absence of corals from the Gallapagos was not verified by him till the sheets of his article in the Boston Journal *were going through the press.* This fact was fully stated in my Report, the reading of which has been so singularly forgotten, and the whole explained at some length: yet he only *verified* it when, long afterwards, his paper was in the press.

But leaving this subject and others, I take up again the abstract of his journal sent home from Sydney. Respecting it he says, "that so far from my having derived the opinions in question, as Mr. D. alleges, from his MSS. at the Sandwich Islands in 1840, they had at that period been several months in the possession of my friends in the United States, having been communicated from Sydney, New South Wales, in substantially the same form as to facts, so far as the influence of temperature on corals is concerned, as that of their publication in January, 1842." After giving his reasons for this, he proceeds to say that the loss of his journals, subsequently proved his wisdom in adopting this course.—(Vol. XLV, pp. 380, 381, of this Journal.)

The *journals supposed to be lost are safe.* By permission from Judge Tappan, they were a few days since submitted to my inspection. Commencing with the date of our first appearance among the coral islands, Aug. 14, 1839, I have followed the journal through, day after day, page after page, till our arrival at Sydney: and what was contained in this original document of which the one at Boston is an abstract or duplicate minutes? A few remarks on the existence and structure of reefs, their forms and composition, and descriptions of a few species. *Not a word on the influence of temperature on the growth of corals*, nor any thing bearing the most remotely on this subject. Before commencing my examination, Capt. Wilkes, who has had the perusal of this with the other Expedition journals, assured me that I should find nothing—but I preferred to satisfy myself by actual examination, as it would better satisfy the readers of this Journal. The seals of his field note-books were broken for me, and these too contained nothing.

This reply to Mr. Couthouy I here close: and as I stated in the commencement, I say again most sincerely, that I could willingly withhold it from the public eye, would truth and honor permit. I should be glad now to draw my pen across the whole, if I could thereby spare one whom I have called a friend, without an unmerited sacrifice on my own part of character and right.


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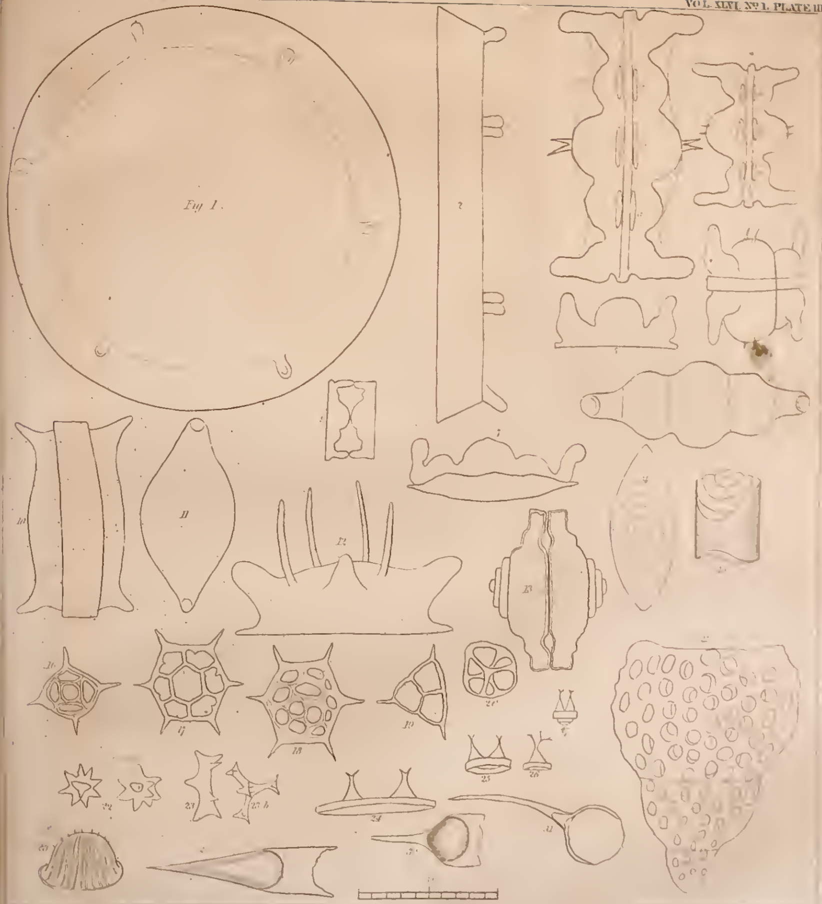

BAILEY'S FOSSIL INFUSORIA.

ART. XVI.—*Account of some new Infusorial Forms discovered in the Fossil Infusoria from Petersburg, Va., and Piscataway, Md.;* by Prof. J. W. BAILEY,—(with a plate.)

THE results of a hasty examination of specimens of fossil infusoria from Petersburg, Virginia, were given by me at the meeting of the Association of American Geologists and Naturalists in Albany, but more careful observations have led to the discovery of several new and interesting forms, and have made me better acquainted with the nature of others which had then been seen only in the fragmentary state. Many of these forms are, I believe, entirely unknown to naturalists, and as additional interest has been given to them, by the fact that several of them occur at the new locality just discovered by Prof. W. B. Rogers at Piscataway, Maryland, as well as at Petersburg, Virginia, I am induced to publish the following account, accompanied by sketches, which although they purport to be mere outlines, will yet serve to give a tolerably correct idea of these very curious and anomalous bodies. Among the most interesting of these bodies are the following.

1. *Podiscus Rogersi*, nob. (figs. 1 and 2, Plate III.) This is the most beautiful fossil animalcule which has ever been discovered. It undoubtedly belongs to the same genus as the curious living forms discovered by Ehrenberg in sea water, and very naturally named by him *Tripodiscus Germanicus*, as his specimens had but three foot-like projections. But as our species shows that *the number of feet may vary from three to seven*, I have ventured to change the generic name to *Podiscus*, and I trust that Ehrenberg will be willing to adopt so slight a modification of the name of this genus, the honor of the discovery of which belongs to him alone. As our species is the largest and most beautiful of the fossil infusoria occurring in the infusorial strata, of which Professor William B. Rogers of the University of Virginia made the truly splendid discovery, I have selected it as peculiarly appropriate to bear the name Podiscus *Rogersi*. The characters of this genus, as given by Ehrenberg, are as follows: "It belongs to the Bacillaria, section Naviculaceæ. Its members are free and possess a round bivalved siliceous lorica, having three [or more] appendiculated processes, and dividing by longitudinal

self-division." He appears to have seen no fossil species, as he describes none but the *P. Germanicus*, which he found alive in sea water at Cuxhaven. Our species may be thus characterized:

Podiscus Rogersi, (figs. 1 and 2.) *Lorica large, orbicular and compressed, having three to seven hyaline lateral processes placed on an elevated circle, within which the disc is slightly concave, and outside of which the surface is part of the frustum of a cone.* The whole surface is beautifully punctate, in a manner to which no engraving could do justice. The most complicated markings on the Coscinodisci scarcely rival the elaborate ornaments of this truly elegant creature. This species is quite common in the fossil state at Petersburg, Va. and also occurs at Piscataway, Md. Our figure is intended merely to show the general size, and the position of the feet. Fig. 1 shows a view of the disc, and fig. 2 is half of an individual seen edgewise.

2. *Zygoceros Tuomeyi*, nob. (figs. 3 to 9.) The remarkable form represented in outline by these figures, occurs both at Petersburg and at Piscataway. I am disposed to refer it to Ehrenberg's genus Zygoceros, which he describes as being "free, Navicula shaped, compressed and bivalved, each end provided with two perforated horns." The figures above referred to will give a better idea of the shape of our species than words will furnish, but the following is offered as an attempt to characterize it.

Zygoceros Tuomeyi. *Lorica having at each end two obtuse horns, with swollen bases, between which are one to three globular projections on each side; those in the middle being largest, and often bearing two spines.* At the base of each of the swellings the shell often shows perforations, (see *a*, *a*, *a*, figs. 3 and 4,) and the whole surface of the shell is covered with shagreen-like asperities. I dedicate this species to M. Tuomey, Esq., to whom I am indebted for fine specimens of infusorial and other fossils from the neighborhood of Petersburg. Fig. 3 shows a large and perfect individual; fig. 4, a smaller one; fig. 5, a young individual; fig. 6, one seen obliquely; fig. 7, an oblique view of one half; fig. 8, a top view; and fig. 9 shows two halves of different individuals united in the manner in which they probably formed chains when living.

3. *Zygoceros rhombus?* (figs. 10 and 11.) Our figure represents a species which so closely resembles the *Z. rhombus* of Ehrenberg, that I am inclined to consider it as most closely allied

to, if indeed it be not a variety of, that species. Ehrenberg thus describes *Z. rhombus:* "Large, lorica turgid, viewed laterally rhomboidal and having rounded angles, surface marked with very delicate striæ, the back having a smooth central zone." These characters apply pretty well to our species, with the exception that the central zone in ours is quite distinctly striated, with two sets of lines crossing each other at right angles. The shape of the horns is also somewhat different in our species from those shown in Ehrenberg's figure. The *Z. rhombus* was discovered by Ehrenberg alive in sea water at Cuxhaven; our species is very abundant in the *fossil* state at Petersburg, Va.

To the genus Zygoceros I now unhesitatingly refer the living species which I detected in Boston harbor, and which I described by the name of *Emersonia elegans.* I propose therefore to change this name to that of *Zygoceros Emersoni.* My *Emersonia antiqua* (fig. 25, Pl. II, of Bacillaria) is probably only the young state of *Z. rhombus?* abovementioned. The living species form zigzag chains.

4. *Triceratium spinosum*, nob. (fig. 12.) This large and very curious species of Triceratium occurs sparingly at Petersburg, Va. Its lorica is triquetrous, laterally slightly convex, with obtuse angles or horns, the surface marked with shagreen-like projections, and bearing four [or more?] large spines. Fossil with several other species of Triceratium at Petersburg. The figure shows the outline of half of an individual.

5. *Navicula? concentrica*, nob. I give this provisional name to the bodies represented in figures 13, 14 and 15. When seen laterally they show an elliptical figure, marked with concentric circular spaces, which when seen edgewise are found to bound a series of gradually diminishing step-like projections. Two individuals [?] probably resulting from spontaneous division, are usually found adhering. Fossil at Petersburg and Piscataway. Fig. 13 shows an edge view, fig. 14 the side, and fig. 15 an oblique view, with the end to the front.

6. *Dictyocha fibula?* (fig. 16.) This occurs in *vast* abundance among the fossil infusoria at Piscataway, Md. It differs from Ehrenberg's *D. fibula*, by generally having five instead of four cells in the convex rhomboid, but I am satisfied that the number of cells is a very variable character in this genus.

7. *Dictyocha aculeata?* (fig. 17.) Our figure represents a fossil species of Dictyocha from Piscataway, which perhaps belongs to Ehrenberg's species *D. aculeata*, for which he gives the following characters. "Cells arranged by sixes in the form of a ring, each cell being spiny within."

In figures 18, 19 and 20, are shown several other fossil species of Dictyocha from Petersburg and Piscataway; some of them are probably new.

In figure 21 is represented a fragment of a singular body, which was rounded or pyriform, with large perforations in its surface. Several fragments of similar bodies were found among the infusoria from Piscataway; and in Plate III, figs. 27 and 28, of my memoir on the Bacillaria, I have represented analogous bodies from Richmond. Their nature is unknown to me.

In figure 22 are shown small globular bodies, with projecting spines, which occur fossil at Piscataway. They resemble somewhat the curious siliceous spiculæ discovered by Bowerbank in the *Tethea lyncurium*.

Figures 23 and 23 *b*. show two other singular shaped spiculæ from Piscataway.

Figures 24 to 27 show anomalous bodies occurring fossil at Petersburg and Piscataway. They consist of an elliptical base, supporting one or two conical bodies which terminate in simple or branched projections.

Figure 28 appears to be half of a body allied to Coscinodiscus, but with radiating striæ instead of cells upon its surface. Fossil at Piscataway.

Figures 29, 30 and 31, represent hollow glass-like siliceous spines, not uncommon at Piscataway, but of whose nature I am ignorant.

None of our infusorial marls that I have yet examined contain any Polythalamia, but in the accompanying tertiary beds of shells, I have found numerous and highly interesting Polythalamian forms, which I propose to describe in a paper which I am preparing upon the American fossil Polythalamia. All the figures which accompany this paper were traced from nature by the aid of a camera lucida eye-piece, and are therefore correct as far as they go, but all the minute markings are omitted. The scale to which they are all drawn is shown in fig. 32, which represents $\frac{10}{100}$ths of a millimetre, magnified equally with the drawings.

West Point, Oct. 31, 1843.

Note.—I take an opportunity afforded while correcting the proof-sheet of the preceding article, to state that since it was written I have examined some sediment which I collected from a small creek, opening into the Atlantic ocean near Rockaway Pavilion, Long Island, and that among many interesting infusorial forms I had the pleasure of finding *recent* specimens of *Podiscus Rogersi*, having *four* foot-like processes. I also found that rare and beautiful form, *Biddulphia pulchella*, and was struck with its *generic* resemblance to the above-mentioned *Zygoceros Tuomeyi.* It is possible that the latter should be referred to the genus Biddulphia. Large and beautiful specimens of *Triceratium favus*, Ehr. occurred with the above, and I noticed also *Dictyocha fibula* and *D. speculum*, besides numerous species of Coscinodiscus and Actinocyclus. Small Polythalamia belonging to the genus Rotulia occurred with the above, thus giving upon our *sandy* sea-coast a mixture of infusorial and Polythalamian forms analogous to that which Ehrenberg has observed in some of the chalk marls of Europe and Africa. In examining mud from Boston harbor, I have recently detected portions of that truly beautiful infusorial form, *Isthmia obliquata.* For full descriptions of it, and of the above-mentioned *Biddulphia pulchella*, see a paper on British Diatómaceæ, by John Ralfs, Esq., in the Annals and Magazine of Natural History, Vol. XII, p. 271. A translation of Ehrenberg's paper, describing some of the interesting forms detected by him living in sea water, will be found in Taylor's Scientific Memoirs, Vol. III, Parts X and XI, accompanied by figures of *Podiscus Germanicus*, *Zygoceros rhombus*, *Triceratium favus*, and several other forms above referred to. J. W. B.

West Point, Dec. 5, 1843.

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*Extract from a letter by Prof. Wm. B. Rogers, to the Junior Editor, dated Richmond, Dec.* 13, 1843.

Dear Sir—I regret that it is not in my power to furnish an account of the *tertiary infusorial formation of Maryland*, recently discovored by me, in time for your forthcoming number. Ere long however, I hope to have that pleasure. In the mean time it may not be uninteresting to your readers to learn that this deposit spreads northwards beyond the Potomac, and is found in *Maryland*, forming at some localities, an important member of the tertiary series. The general aspect of the mass as seen near Piscataway, is like that of the principal Virginia localities, and its position is above but apparently near the base of the meiocene. On some of the fragments in my possession, are well preserved impressions of meiocene shells, among which I may mention *Astarte undulata* as particularly distinct.

Prof. Bailey, *our* Ehrenberg, having applied his skillful observation to a small portion of the material which I sent to him by letter, has confirmed my ruder determination as to the prevalence of various species of Coscinodiscus in the mass, and has besides recognized a variety of other interesting forms. Through his kind sanction, I annex a list of some of these curious and beautiful objects, referring to his own memoir and accompanying figures for a more detailed description.

*Coscinodiscus argus; C. excentricus; C. lineatus; C. oculus-iridis; C. patina; C. radiatus*, &c. *Actinocyclus senarius; A. bisenarius; A. quindenarius*, &c. *Podiscus Rogersi*, occurs sparingly. *Zygoceros Tuomeyi*, is not rare. *Gaillonella sulcata?* abundant. *Dictyocha fibula?* extremely abundant, far more so than at any other known locality. *Dictyocha speculum*, abundant. Several large and new? species of *Dictyocha*; several small species of *Navicula*, one of which is panduriform; besides many other new and interesting objects, of which Prof. B. will give an account in the continuation of his valuable memoirs on our infusorial fossils.

The extent to which the infusorial beds of the tertiary have thus far been traced, invests them with a far higher geological importance, than in my first observations I anticipated; and should they be found, as I believe they will, stretching northwards to the Delaware, and southwards far beyond the Roanoke, they will deserve to be regarded as a prominent portion of our great Atlantic tertiary series, and as one of the most striking objects in the geology of our great Atlantic plain.

Very truly your friend,

Wm. B. Rogers.

*B. Silliman, Jr., Esq.*

ART. XVII.—*Review of the New York Geological Reports.**

THE geological survey of this vast state is at length completed, and the final Reports of the State geologists have passed through the press, with the exception of the volume on Palæontology. The zoological volume of this series has already fallen under our notice, (vid. ante, Vol. XLV, p. 397,) and the mineralogical division is also before our readers in the present number, (see p. 25.) Our present intention is to make a rapid survey of the general scope of the four volumes of purely geological matter which we have before us, comprising the labors in each of the four great original divisions of the state; while we reserve for the future, a review of the volume on palæontology by Mr. Hall, as well as any more particular mention of the individual reports now under consideration, which it may be desirable to make.

A word upon the mechanical execution of the work before entering on its details. The typography is large and tolerably clear, although a punctilious printer would, perhaps, think it sometimes "muddy." The wood-cuts are done generally very well and some of them are unexceptionable; so are some of the large fossils in lithograph, of which we would particularly notice plates 19 and 20 of Mr. Mather's volume, which are admirably managed. Many of the sectional plates, however, lack neatness, although doubtless sufficiently good for the object. An enumeration of the sections and plates, would be alike tedious and unprofitable. Separate from the volumes, is a geological chart three and a half feet by

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* Natural History of New York, Part IV. Geology, Part I, comprising the Geology of the First Geological District. By WILLIAM W. MATHER, Prof. Nat. Hist. in Ohio University. Albany, Carroll & Cook, 1843. 4to, pp. 706, illustrated with 46 colored sections, views and figures of fossils, and numerous wood-cuts. $4.

Natural History of New York, Part IV. Geology, Part II, comprising the Survey of the Second Geological District. By EBENEZER EMMONS, M. D., Prof. Nat. Hist. in Williams College. Albany, W. & A. White and J. Visscher, 1842. 4to, pp. 437, with 17 plates of geological sections, fossils and views. $4.

Natural History of New York, Part IV. Geology, Part III, comprising the Survey of the Third Geological District. By LARDNER VANUXEM. Albany, W. & A. White and J. Visscher, 1842. 4to, pp. 306, with 80 wood-cuts of fossils and sections. $4.

Natural History of New York, Part IV. Geology, Part IV, comprising the Geology of the Fourth Geological District. By JAMES HALL. Albany, Carroll & Cook, 1843. 4to, with numerous plates and wood-cuts. $4.

three feet, colored so as to give a general view of the range, extent and bearings of all the principal formations of the state.

The readers of this Journal are doubtless aware that the geological survey of New York was conducted by four principal geologists. To each of these a certain district was assigned, and each made his own report in a separate volume. W. W. Mather surveyed and reported on the first district; E. Emmons on the second; L. Vanuxem on the third; J. Hall on the fourth. This division of labor undoubtedly brought the work more speedily to a close, and has probably given to the public a more minute, local geological knowledge, than could have been otherwise obtained; but as the districts were laid off before the number and extent of the geological formations were known, their boundaries are comprised within geographical rather than geological lines, and the final reports, in consequence, are not a little prolix, are voluminous and expensive, and do not give as clear and connected a view of the geological features of the State as could be wished. The same remark applies to descriptive county geology, which has been adopted in part, in the reports of the New York geologists. It is a good plan for the inhabitants of the State generally, inasmuch as they can refer easily to the remarks which apply to their own immediate vicinity; but it necessarily involves repetition, and gives but a disjointed and piecemeal view of the country to be described. We are of opinion that before this work can become generally useful and extensively circulated, it must be condensed and arranged into one compendious volume.

In proceeding with the review of the work before us, we shall divide it into two parts. In the first, we shall endeavor, by culling from the descriptions of all the four districts, to give a general outline of the geology of the State; in the second, which will appear in a future number of this Journal, we shall collect together some of the most important and interesting details. More than this would be beyond the objects we have in view.

If we except the superficial, unconsolidated, recent deposites, which occupy but a very limited area, all the rocks of the State of New York are older than the coal formation. They belong, either to the unstratified crystalline,—the primary of older writers,—the stratified non-fossiliferous, or to the older palæozoic strata, which latter terminate upwards with an outlier of a conglomerate, the lowest member of the coal formation, found on the highest elevations, near the Pennsylvania line. The question, therefore, as to the existence of coal within the boundaries of the State, is at last fully settled, and a knowledge of this fact will be the means of preventing many from embarking capital and labor in fruitless attempts in search of this combustible. This is the more especially important, since there are bituminous shales amongst the New York strata, which are apt to mislead the unwary, and have already caused not a little disappointment to enterprising citizens. The absence of coal is a matter which the inhabitants have truly to deplore. Since, however, it exists in Pennsylvania, not far from the State line, and the means of transportation are daily increasing, New York can be easily and cheaply supplied from the inexhaustible stores of her neighboring State.

*Primary system.*—The non-fossiliferous rocks, both crystalline and stratified, are confined to an irregular, circular area, in the northeast, and a small triangular corner in the southeast, covering, in all, about one-third of the State. On the geological chart, they are all included in one color, a pink, and denominated "Primary system."

The prevailing rock in this system is gneiss. Granite exists, but it is unimportant, both as regards its extent and economical relations. The hypersthene, on the contrary, though long supposed not to be an American rock, was found by Dr. Emmons to occupy a triangular area extending over nearly the whole of Essex county, and to be traversed by valuable beds and veins of magnetic oxide of iron, probably in larger and more extensive masses than any in the United States.

Besides the above rocks, there exist in the northern primary region, primitive limestone, serpentine, Rensselaerite, hornblende, sienite, talc, or steatite, porphyry, and trap.

Of all these, the hypersthene rock and primary limestone are the most important, in an economical point of view; the former on account of the rich beds and veins of iron ore, the latter as affording materials for constructions and agriculture.

*Taconic system.*—On the extreme eastern boundary of the State, and extending into Vermont and Massachusetts, is a system of rocks lying locked in between the New England primary, on the east, and the lowest fossil-bearing rocks of New York, on the west. Dr. Emmons endeavors to show, that these rocks form an isolated group, distinct from the primary, and yet not metamorphic palæozoic strata: he has given them the name of *Taconic system*, since they exist on both sides of a range of hills, known by the name of the Taconic mountains, running north and south, almost coincident with the eastern boundary line of the State. He admits that the slates and shales composing this system closely resemble the lowest fossiliferous schists; but endeavors to prove that they can not be these latter strata altered, because there is a want of similarity in the position of the rocks of the Taconic system and those fossil-bearing strata to which they are referred; "for," says he, "we do not expect that by any agent, a slate can be changed into a limestone, nor is it likely to be; neither will the order of superposition be changed by metamorphism." Admitting this, we do not consider the argument altogether conclusive, because, according to Dr. E., the Taconic series is of great thickness, and though, in its present upturned and contorted position, it occupies but a narrow belt, when spread out of course had a much greater superficial area: but equivalent beds, identified by their fossils at distant localities, may be sandstones or argillaceous deposites in one place, and a limestone in another. The Taconic rocks may have title, as Dr. E. contends, to be considered a distinct system, but fully to establish this, demands, we think, other and more decisive evidence.

Dr. E.'s arguments in proof that the strata under consideration are distinct from analogous primary beds, is founded on difference in texture, color, association, chemical composition and mineral contents. Comparing them, he remarks:

"Taking, for example, the talcous slates of the two systems, I have no hesitation in saying that constant and reliable differences exist, and may be found in all careful and close examinations. These differences exist in the quality of the slates themselves, particularly in the color and lustre of the laminæ, and their peculiar contortions. But more decided differences are found in the associations of the rocks. The talcous slate of the primary system is universally associated with hornblende or soapstone, or both; while the talcous slate of the Taconic system is never associated or connected with either of these rocks; or, to state the fact in other words, never passes into them, whereas, in the former case, it does. Another fact of the same nature is also well determined by observation, viz. that the imbedded minerals belonging to each rock are remarkably distinct. Actinolite, epidote, titanium, auriferous sulphuret of iron, &c., are never found in the Taconic system.

"This brings us to the conclusion, then, that where the associate minerals are different, the rocks themselves are different; and there are so few exceptions to this statement, that it appears to the writer to furnish sufficient grounds for separating one system from the other, by the aid of characters sufficiently important and decisive for all the purposes of geology.

"I have confined my remarks to the differences in the slates. Equally important are they, when we compare the limestones of the other systems with those of the Taconic. While the texture and grain of the limestones of the two systems differ, there are still more distinctive and specific marks which may be employed. The presence of graphite in the limestones of the primary system, may always be depended upon, even in hand specimens; for not an instance has occurred in which this substance has appeared in the limestone of the Taconic system, or in an aqueous deposite. Besides, the instances are not very numerous in which any minerals of the primary rocks are found in this system. White pyroxene and tremolite do occur at a few localities; but the peculiar constitution of graphite makes it very doubtful whether it is ever produced in rocks of aqueous origin, except where they have been subject to the powerful action of melted lavas, or to the influence of caloric in some other mode. Molecular action, unaided by heat, is insufficient to effect the decomposition of carbonate of lime, so far as the development of carbon from carbonic acid is concerned; and then its combination with metallic iron to complete the chemical constitution of this substance, appears to be still more difficult. Wherever graphite exists, we may rest satisfied with the conclusion, that the agency of caloric has been there, and in a state, too, of great intensity.

"If, then, reliance can be placed upon lithological characters, and upon associate minerals, we may raise something more than doubt as it regards the identity of the Taconic rocks with the true primary system, or certain members of it. In truth, such confidence is felt in the correctness of the principles which have influenced me in proposing their separation, and that they possess characters fully sufficient to give them an independent place in the systems of the day."

This test of the origin and geological position of a limestone, by the presence of *graphite*, does not seem to be so conclusive in all parts of the United States as it would seem to be in New York. Professor H. D. Rogers, in his report on New Jersey, describes a locality, four miles southwest of Sparta, in that state, where there is a belt of limestone containing graphite, which he considers as belonging to formation II, i. e. the equivalent of the Black River and Trenton limestones of New York, but altered by the vicinity of a granitic dyke. Speaking of this locality on p. 73 of the New Jersey report, Prof. Rogers remarks:—

"Immediately upon the western side of this curious vein, and ranging along the base of the hill, occurs the narrow belt of altered limestone. The gradation of change which here exists between the blue and earthy limestone, and the white crystalline rhombic spar, is distinctly traceable as we approach the igneous dyke. In a breadth not exceeding fifty feet, we discover every degree of modification which the rock can undergo by heat. The first intimation which the limestone gives us of its having been subject to the igneous agency, is its passage from the ordinary earthy texture to a sub-crystalline one.

"We next behold a slight change of color to a lighter tint of blue, and at this stage of alteration, we notice the first development of the *graphite*, as yet seen only in small, but very brilliant scales, which are oftentimes hexagonal. Very soon the mass becomes mottled with white, minutely granular carbonate of lime, the spangles of graphite growing progressively larger. Approaching still nearer to the dyke, the whole rock assumes the white sparry character, and contains near the line of contact, besides the graphite, several of the numerous crystalline minerals of the vein itself. So completely has the injected matter of the vein been mingled, in many places with the fused substance of the limestone, that no distinct line of demarcation is discernible between them." And on p. 74 he goes on to say: "The invariable occurrence of *graphite* in portions of the altered belt *remotest* from the dyke, and its never existing in more than a very trivial quantity, even adjacent to the vein where the other extraneous minerals are frequently present in great excess, strongly imply that it has been derived from the elements of the blue limestone itself, which may easily be proved to contain an adequate quantity of iron and carbon for the production of this mineral."

Here, then, appears to be an unequivocal instance of the existence of *graphite* in an altered protozoic limestone of aqueous origin; and the graphite is in greatest abundance, not in the immediate vicinity of the dyke, where the heat must have been most intense, as we should expect from the inferences of Prof. Emmons, but in the altered parts of the limestone more remote from the centre of igneous action.

The Taconic rocks are supposed by Dr. E. to be the equivalent of the lower Cambrian of Prof. Sedgwick. It will appear however, in the following extracts from Mr. Murchison's address, delivered at the anniversary meeting of the Geological Society of London, February 17th, 1843, that the Cambrian formation is now no longer recognized as a distinct system. Speaking of the palæozoic rocks of the British isles, we find on pages 16 and 17, the following remarks:—"Prof. Sedgwick has reassured himself that there are fossiliferous slaty masses of great vertical thickness, which rise out from beneath lowest Silurian rocks of North Wales hitherto described, and occupying the region of Merionethshire and Snowdon, alternately rest upon chloritic and micaceous schists (Menai Straits), into which they do not pass. The lowest of these fossil bands, forming the summits and flanks of Mod Hebog and Snowdonia are, he conceives, several thousand feet below the Bala limestone.

"The hope, however, which was entertained by my friend of finding these vastly expanded and lower members characterized by peculiar groups of fossils, has been frustrated, and whatever may be the thickness of this lowest palæozoic division, in which he has collected a great number of species, he now fully admits, that zoologically it is from top to bottom, a lower Silurian series. Charged as it is with characteristic Orthidæ and trilobites, including the Asaphus tyrannus, so characteristic of the lowest Silurian rock, there are, as may be expected, a few new and undescribed species: and, among these, an Ophiura will not appear the least extraordinary.

"The base of the palæozoic deposites, as founded on the distinction of organic remains, may now, therefore, be considered to be firmly established; for the lower Silurian type is thus shown by Prof. Sedgwick himself to be the oldest which can be detected in North Wales, the country of all others in Europe, in which there is a great development of the inferior strata."

It is evident from the above passages, that the most recent observations in England now recognize no system between the crystalline schists or primary stratified, and the true Silurian system. The Taconic rocks must, therefore, be the equivalent either of the lower Silurian, of Wales, or else must be a series wanting in England; in that case, they may form a new system.

The rocks which compose the Taconic system are few in number, viz. granular quartz, slate, and limestone, repeated thus in the ascending order: Stockbridge limestone, granular quartz, magnesian slate, sparry limestone, Taconic slate. There are, therefore, two kinds of limestone, and two kinds of slate.

The most important economical products of this system, are the white and clouded marbles, furnished by the calcareous beds; the hematitic iron or limonite, derived from the decomposition of the slates and slaty limestones, the white siliceous sand, for glass and sand paper, and for sawing marble; procured from the granular quartz.

The absence of trap dykes in this system is remarkable. Prof. Emmons has never yet seen an instance of any description of injected rocks associated with the Taconic beds, and he infers that very few disturbances have occurred since the general uplift of the country.

*New York system.*—It is the older palæozoic rocks, or protozoic, of Murchison, that form the characteristic geological features of the State of New York. They occupy all the country lying between lakes Ontario and Erie, and the Pennsylvania line; also, the greater part of the tract situated south of the primary region; i. e. south of a curved line running along Black river, down the valley of the Mohawk to Johnstown, thence along the meanderings of the Sacandago river to near Glen's Falls; thence nearly northeast, to the south end of lake Champlain; besides a semicircular belt lying north of the primary region, and between it and the river St. Lawrence and Canadian line; in all, covering at least two thirds of the entire State.

Under the name of New York system, Dr. Emmons includes all the oldest fossiliferous rocks, up to the sandstones of the Catskill mountains. Mr. Vanuxem includes these in the system, and extends it to the conglomerates of the coal formation. Mr. Hall, on the contrary, excludes from the system, not only the sandstones of the Catskill mountains, but also the slaty sandstones and shales in the southern part of the State, known as the Chemung group; and considers them both as belonging to the Old Red or Devonian system. And, in truth, it is matter of doubt which is the correct hypothesis; as we shall see when we come, by and by, to sum up the evidence derived from organic contents, lithological character and superposition.

No region ever yet explored, presents these protozoic strata, as the New York geologists aver, in so extensive, undisturbed development, as their State; and no country seems to afford such fine natural sections suited for the study and classification of rocks of this age. It is for this reason, that the New York geologists, following Dr. Emmons' recommendation, have adopted the term "*New York system.*" If a local nomenclature be admissible, no country can be better entitled to transfer its name to a geological system. We object, however, to local terms, except as provisional, because they are not generally applicable, and because they multiply synonymes, and render the geological vocabulary unnecessarily complicated.

No system of nomenclature is, in our view truly worthy of adoption, but one that is universally applicable to every region of the earth; pointing directly to the place in the chronological scale, which the formation designated occupies.

The total thickness of the New York system is between seven and eight thousand feet. According to Dr. Emmons' classification, the system in question consists of four principal divisions, named from the districts where they are in greatest force and best characterized. In the ascending order, they are as follows: *Champlain division*, *Ontario division*, *Helderberg division*, and *Erie division*.

The area which each of these occupies in New York is as follows:

The first division encircles the primary; and its upper strata extend from the union of the Hudson and Sacandago rivers, south down the valley of the Hudson, occupying the country between the eastern State line and the Helderberg range of mountains. The whole region comprising this division in New York forms a figure resembling the written letter *g*.

The Ontario division ranges along a belt of country running east and west, parallel with the southern shore of the lake of that name, nearly of uniform width, being the distance between lake Ontario and the northeast corner of lake Erie; except near its eastern termination, where it first expands between the eastern shore of lake Ontario and Fish Creek, and then inclining a little southerly, rapidly tapers off to a point, and vanishes near Schoharie.

South of the latter, and parallel to it, is the Helderberg division, occupying a narrower but longer strip of country; for near Schoharie, it sweeps off in a curved line towards the south, along the Helderberg range, parallel with the Hudson river, as far down as Kingston, and thence southwest to the great bend of the Delaware, where the Jersey's northern State line strikes that stream.

The fourth, or Erie division, has a superficial area about equal to that of the other three put together. Running west and east, it stretches nearly across the State, covering the country between the Pennsylvania line and the south boundary of the Helderberg division; i. e. the southern third of the State of New York.

In the eastern portion of this tract, the Erie division is covered by the sandstones of the Catskill.

Each of the four divisions embraces the following rocks, beginning with the lowest:

*Champlain division.*—Potsdam sandstone, calciferous sandrock, Chazy and birdseye limestone, marble of Isle La Motte, Trenton limestone, Utica slate, Loraine shales, grey sandstone, conglomerate.

*Ontario division.*—Medina sandstone, green shales, and oölitic iron ore, Niagara limestone, red shale, Onondaga salt and plaster rocks, Manlius water-lime.

*Helderberg division.*—Pentamerus limestone, Delthyris shale limestone, Oriskany sandstone, Encrinital limestone, Caudigalli grit, Schoharie grit, Helderberg limestone.

*Erie division.*—Marcellus and Hamilton shales, Tully limestone, Genesee slate, Ithaca and Chemung shales and grits.

Without at present attempting a detailed description of the individual members, let us review them as a whole.

The lithological character of the Champlain group is siliceous at the base; gradually acquiring calcareous matter as it increases in thickness, it becomes a pure limestone rock; then we have an intermixture of argillaceous sediment, which increases in quantity, until the calcareous particles give place to a dark colored clay or mud, in the form of shale; the argillaceous beds then become by degrees siliceous, and finally, a siliceous deposite, nearly pure, takes their place. Here we have an interesting example of a series of changes in the transported sediment during the period of deposition of this division; yet, at the same time, so imperceptible is the blending of adjacent strata, that it carries with it the conviction that no link in the chain is wanting; that nature has been permitted in that region, quietly and without interruption, during a long period of time, to do her work.

The Potsdam sandstone, the base of this group, is the oldest fossiliferous rock yet known in the United States.

It is in the middle portion of the Champlain division that the family of trilobites first appears, and there, also, are they most abundant. The genera *Isotelus*, *Cryptolithus*, *Calymene*, *Illænus*, *Bumastus*, *Ceraurus*, are mostly confined to it. The so called *Fucoides demissus*, now supposed to be a coralline, belongs exclusively to the early part of this division. That curious fossil, the *Graptolite*, is peculiar to these rocks. The greater number of species belonging to the genera *Leptæna*, *Orthis*, *Atrypa*, *Delthyris*, *Cypricardites*, are found in the Champlain division.

The western equivalents of the Champlain division, seem to be the magnesian limestones and sandstones between the mouth of the Wisconsin river and the falls of St. Anthony; and the lowest limestones of the Ohio valley, i. e. the blue limestones and marls of the reports on Ohio and Indiana.

From a comparison of the fossils of this division with those of Great Britain, Dr. Emmons is of opinion that its English representatives are the Bala limestone and the lower Silurian.

The Ontario division is composed of reddish sandstone and fossiliferous shales below; limestones and calcareous shales in the middle portion; red shales, gypseous shales, platerstone and water limestone in its upper part. The fossils of this group are, on the whole, not so abundant and remarkable as those of the preceding group. Two peculiar species of *Fucoides* belong to it; also, disk-shaped and pentangular *entrochites*, *tentaculites;* the genera *Littorina*, *Cytherina*, *Avicula*, a species of *Atrypa*, and *Orthis*, a *Lingula*, a *Strophomena*, *Asaphus*, and portions of two peculiar species of trilobites, to which the generic names of *Hemicrypturus* and *Eurypterus* have been given. Also, a new genus of Crinoidea, called *Cariocrinus*.

In an economical point of view, this is probably the most important division in the New York system, as furnishing all the plaster, water-lime, and salt water of the State of New York; besides, it affords fine beds of oolitic and fossiliferous iron ores, similar to that in Pennsylvania, which supplies much of the Juniata iron.

The most remarkable fossils in the Erie rocks are *Goneatites*, *Orbiculas*, the curtain and retort-shaped *Fucoides;* several species of *Delthyris* with the hinge very much produced; some species of *Atrypa* and *Orthis*, more or less of an orbicular form; some peculiar *Cypricardites*, *Avicula*, *Orthonata*, *Strophomena*, *Orthocera;* a trilobite which has received the generic name *Dipleura;* but the crustaceans seem to have been rare during the deposition of these strata. Here we find the first vestiges of land plants in the New York system; the *Goneatites*, too, have not been found as yet any lower in the series.

Interspersed in the bituminous shale at the base of this group, some partial patches of coal occasionally occur; but all the numerous explorations in search of a regular seam in the vicinity of these rocks, have ended in disappointment. The fact is, these beds lie many hundred feet below the base of the true coal measures, and were deposited long previous to the period when the circumstances favorable to the formation of coal existed. It does not appear that this division has yielded any valuable minerals: some of its members afford, however, some tolerably good building materials.

The representatives of the rocks of this group in the west, are the black slate and fine sandstones of Scioto, in Ohio, of the knobby region in Indiana and Kentucky, and the southwest part of Illinois, and the strata in the high ground of middle Tennessee, and the iron region of the same district.

The lower and upper beds of this group, appear to be absent in the West, but some of the middle beds have been identified.

If the specific determination of fossils is to be depended upon, the inference seems to be that the lower part of the upper Silurian system of England, represents the middle beds of the Ontario division of New York.

The Helderberg division is chiefly calcareous; limestone and shaly limestone below, sandstone and grit in the middle, and limestone above. The most remarkable fossil genera in these strata, are *Pentamerus*, *Euomphalus*, *Hipparionix*, a fucoid, in the form of a cock's tail; a trilobite with a forked tail, *Odontocephalus; Cyrtoceras;* several species of *Strophomena*, *Orthis*, *Atrypa* and *Delthyris;* a variety of corals; some fossils considered to be defensive fin-bones of fishes; *Asaphus*, *Ascidapsis*, *Acanthaloma*, *Dicranurus*.

It does not appear that the Helderberg rocks have afforded any valuable materials, except such as are employed in constructions and agriculture.

Some of the fossils of this group bear a striking analogy, if they be not identical with a few of those which occur in the upper Silurian rocks of Murchison, and there is, perhaps, little doubt but they are cotemporaneous deposites.

The lithological character of the Erie division, as a whole, is argillaceous, viz. black and blue shales at the base, with intercalated thin beds of impure limestones in the middle, and shale and grits above.

The upper part of the Erie division passes by almost imperceptible gradations into the Catskill group, which is considered by Mr. Vanuxem to be equivalent to the old red sandstone of England.

It consists of light colored, greenish-gray sandstone, usually hard; a fine-grained red sandstone, red shale or slate; of grindstone grit; and a peculiar concretionary and fragmentary mass, like the *cornstone* of the old red sandstone of England.

The group in question is rather barren in fossils. Two species of Cypricardites have been found peculiar to it; also, some remains of a remarkable fish, considered the same as the *Holopticus* of the Devonian system of England. Fossil plants are more common in the Catskill group than shells or bones, giving rise sometimes to coal, accompanied by pyrites, but they never exceed one foot in length and breadth, and one inch in thickness. Until the position and age of this rock was determined, strong hopes were entertained that valuable seams would be discovered. "Instances are but too frequent where explorations have been undertaken," says Mr. Vanuxem, "which have been attended with much anxiety of mind, and have resulted in nothing better than a waste of time and loss of money."

The flora of the Catskill group shows an approximation or transition to the true carboniferous era. Amongst those of uncommon form, we recognize some of the familiar family of Sigillaria, so abundant in the coal measures.

In the extreme southern portion of New York, a few outliers of a conglomerate appear, the same which is developed in the adjoining districts of Pennsylvania, and forms the base of the adjacent coal formation, and considered the equivalent of the millstone grit of England.

No traces, however, of any limestone exist between this conglomerate and the Catskill group, occupying the position of that limestone which is so important and remarkable a member of the carboniferous system in Virginia and most of the western States, characterized by the Pentremite and Archimedes, often oolitic in its upper portion, and now universally admitted as the American representative of the mountain limestone of Europe.

Mr. Mather remarks, (p. 294,) "Prof. Hitchcock was considered years ago, as having almost demonstrated the equivalency of the red sandstone of the Connecticut valley, to the *new red sandstone.* There can be scarcely a doubt, that the sandstone east of the Blue Ridge and Highlands; that of the Connecticut and of the Housatonic valleys; and doubtless those of lake Superior, the Rocky mountains, and Nova Scotia, are identical in age, as they are in their general characters and in their associated rocks and minerals, and in their fossils, so far as we know."

We have spoken now in general terms of all the great geological formations of the State, up to the base of the coal formations. It remains only, for the present, to make a few remarks on the recent partial deposites.

Dr. Emmons describes these under the head of tertiary, though he considers them as belonging strictly to the post tertiary, of Lyell. Two thirds of these deposites consists of stiff blue clay, destitute of shells below; the rest is a yellowish sand, with an intervening mixture of sand and clay. It is in this mixture only that shells have been found. The genera are: *Myas*, *Pectens*, *Tellinas*, *Saxicavas*, and *Terebratulas*, in a state of wonderful preservation, showing that the deposite took place quietly and without interruption. The upper fossiliferous portion seems, however, to have been to a great extent swept away, as it is found only in sheltered situations. The principal localities of these recent deposites are the great valleys and basins of the eastern and northern parts of the State.

To sum up, then, in a few words, the remarks in the foregoing pages: The geological formations of the State of New York belong chiefly to the older fossiliferous rocks below the coal measures. Granite is rare, but the gneiss and mica slate system is well developed and occupies a considerable area in the northeast. The carboniferous system is absent. The new red sandstone system is very partially developed in the southeast. The oolitic and cretaceous systems are entirely wanting. So also is the tertiary, according to the usual acceptation of the term.

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## Art. XVIII.—*The Variation and Dip of the Magnetic Needle at Nantucket, Mass.;* by William Mitchell.

I am not aware that the dip of the magnetic needle at Nantucket has ever been published; nor am I aware that this element or that of the variation, has, till recently, been obtained in a manner having claim to accuracy; yet a glance at the map of the American coast, shows it, at once, to be an important magnetic position. In the year 1834, I obtained the variation of the needle by a series of observations of the sun's rising and setting amplitude, and also of his azimuth at equal altitudes before and after noon, and the result was 8° 27′ westerly. During the years 1837 and '8, it was repeatedly obtained, and near the close of the latter, stood at 9° 02′ 19″. In the summer of 1842, I established a meridian line on an open plain with stations fourteen hundred feet asunder, and remote from all visible local magnetic influences, and, with a long delicately formed needle, carefully suspended, made a great number of observations, principally during the months of August and September, the means of which showed a variation of 9° 9′. The amount of variation for the month of September, 1843, was obtained by the following method, which though far more laborious, is, when performed with care, decidedly the most satisfactory. From each station of the meridian line, the direction of the needle was referred by means of sight vanes, to a movable mark equidistant with the opposite station of the meridian, and the angle thus indicated by each settled position of the needle, was carefully measured with a sextant, properly adjusted, allowance being in each case made for the parallax of the instrument. An equal number of observations was made before and after noon at each station, and the mean of all, viz. 9° 09′ 59″, may I think, be deemed a close approximation to the truth. On comparing the result last obtained with those of former observations, it is evident, that the westerly variation, which has been for years increasing, is still advancing, though at a diminished rate.

The inclination, or magnetic dip, was obtained by numerous observations between the 20th of September and the 10th of November of the same year. Those of the latter month were made at various localities within the compass of a mile, a condition which proved of importance. The instrument employed was one made by Gambey, furnished with two needles, manifestly a good article. An equal number of observations was made before and after the noon of each day; an equal number in each period with each needle; an equal number of the observations was taken with the instrument facing east and west, and an equal number with the poles of the needles reversed. The readings consisted of the mean of both ends of the needles, and the result of all, indicated a dip of 73° 41′.25.

How far the means employed in obtaining these elements, will entitle these results to confidence, is for those interested in the subject to judge; in the practical details, neither care nor labor has been spared.

Nantucket, Nov. 11, 1843.

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## Art. XIX.—*Re-examination of Microlite and Pyrochlore;* by Augustus A. Hayes.

The July number, for 1842, (Vol. xliii, p. 33,) of this Journal, contains a short paper, by Mr. J. E. Teschemacher and myself, on the identity of microlite and pyrochlore. In the same number, (p. 116,) Prof. Shepard has published an article entitled, "Want of identity between Microlite and Pyrochlore." Mr. Teschemacher, from studying the crystals of these minerals, arrived at the conclusion that they are of the same species. Prof. Shepard has, in detail, given his objections to the conclusions of Mr. T. As Mr. T. has seen nothing in the reply of Prof. S. leading him to doubt the correctness of his statements, he declined noticing the article. It is not my intention to offer any remarks on that part of Prof. Shepard's paper which contains his objections on "natural history grounds."

I shall also leave those "rules," which separate the microlite from pyrochlore, and place it with *yttro-tantalite*, their full influence. The kindness of Mr. Teschemacher and Mr. F. Alger, has enabled me to review my experiments on the microlite, and by placing in my hands fine crystals of both microlite and pyrochlore, laid me under obligation to communicate any additional information my results might afford.

I gave the pyrognostic characters of microlite, which are distinctive for the species, in the paper published by Mr. Teschemacher. They correspond to those of pyrochlore, so far as they were known to me. Pyrochlore was considered as a titanate of lime, with other oxides crystallized together. Besides the correspondence exhibited with fused reagents, I ascertained that the microlite was *soluble in hydrochloric acid.* The solution nearly neutralized by an alkali, gave to shavings of gall-nut *a red brown color.* When the acid solution was enclosed in a tube, with a bit of metallic zinc, a *bluish purple color was produced.* The analysis of one grain was made as an addition to the chemical characters. Some months after I made this examination, I saw for the first time Prof. Shepard's paper, (Vol. xxxii, p. 338, of this Journal,) giving a "chemical examination of microlite," and was not before acquainted with the fact, that the statement of its composition, given on the authority of Prof. S., as an ore of cerium, had been corrected. By the "examination" referred to, the evidence that columbic, instead of titanic acid, is the electro-positive constituent of microlite, I consider conclusive. I therefore most freely retract the opinion I expressed in relation to this point, and shall show how I was led into the error.

### *Analysis of the Microlite, from Chesterfield, Mass.*

Regular crystals of the microlite were broken into fragments; of the parcel, about one fragment in twenty-five had a yellow color;* the residue presented shades of brown. Diluted hydrochloric acid was warmed on the fragments, to remove any adhering minerals. No lime or uranium was dissolved, but a little peroxide of iron was contained in the solution. After washing the fragments

* Mr. Teschemacher has called my attention to some minute, transparent, yellow, and highly brilliant crystals, which, with columbite and microlite, are found in the Chesterfield granite. They have the characters of a columbate, but differ in form from microlite. Mr. T. has a crystal of microlite, much modified by an uranium mineral, crystallized with it. Generally the yellow stains on the albite are the most marked indications of the existence of microlite crystals.

in water, they were dried on paper. Weighed at 60° F., 10 grains lost in pure water at that temperature 1·850, which gives 5·405 as the sp. gr. of the specimen.

The fragments were reduced to a fine powder, in an agate mortar, and dried over sulphuric acid, at about 60° F. A platina capsule, which had been recently ignited and cooled, contained 10 grains of the powder. After exposure to a bright red heat for twenty minutes, and cooled to 60° over sulphuric acid, the loss was 0·040. Exposed on the balance twelve hours, nearly the original weight was found, from absorption of atmospheric vapors. The microlite is therefore anhydrous.

A. Ten grains of the mineral, in fine powder, had been ignited, and were mixed with 200 grains of pure bisulphate of potash, in a large platina crucible. Heated to moderate redness, the powder dissolved into a yellow clear fluid. After cooling the crucible, water was added, and the whole again heated; the clear fluid resulting from the use of successive portions of water, being passed through a prepared filter. The white powder which remained was boiled in diluted hydrochloric acid, successive quantities being used and passed through the filter. Boiling water left undissolved a lighter, flocculent powder, which was collected on the filter. When sulphydrate of ammonia was added to this powder, it rendered it dark colored, and finally black. Twelve hours after, the sulphydric solution was removed, and the powder washed in water. Hydrochloric acid rendered the powder nearly white, and boiling water removed all traces of acid. After a copious washing in water, the powder has a slight degree of solubility. The filter and contents, dried, were heated red hot, cooled over sulphuric acid to 60°. 7·900 of pure dry columbic acid remained after deducting 0·004 ashes, left by filter.

B. After all the acid liquors, from the columbic acid, had been boiled, and their bulk greatly reduced by evaporation from a flask, the sulphuretted solutions from the same were added, drop by drop, so as to saturate the warm acid fluid with hydrosulphuric acid. A slight white precipitate had appeared during the boiling, it became darker colored, and was increased in bulk by a deposite of sulphur. When the odor of hydrosulphuric acid had been dissipated, the brown precipitate was separated from the clear fluid, washed in water, and collected and dried. By heat, sulphur was burnt off, and the addition of nitric acid, and subsequent ignition, left a white, heavy powder, weighing 0·200.

C. To the transparent acid fluid, a few grains of chlorate of potash were added, and the whole was heated. Chlorine gas escaped, and after the liquor became cold, ammonia was added to render it neutral. An excess of the same alkali was added, and the vessel closed; a yellow hydrous precipitate subsided, becoming flocculent. The clear fluid was passed through a filter, under a bell blass, containing hydrate of lime, and the yellow precipitate was collected on a filter, and carefully washed in water containing muriate of ammonia. Diluted nitric acid redissolved the yellowish brown precipitate, leaving on the filter a mere trace of a white powder, which was added to that of B. The nitric solution was rendered nearly neutral by carbonate of potash, and clear crystals of pure sulphate of potash were dissolved in the fluid while it was warm. When cold, the white heavy precipitate which at first appeared, was mixed with a more crystalline salt. Twelve hours after, no increase in the quantity of the latter salt was noticed. These precipitates were separated from the fluid, and washed in proof spirit. Hot water dissolved one part, leaving a heavy insoluble salt, which, after having been ignited, weighed 0·150 grain, and had the characters of sulphate of lead.*

D. The aqueous solution of the lighter salt, would afford no precipitate with ammonia. It was mixed with the proof spirit solution, and the whole boiled to disengage alcohol. Ammonia in excess, gave a yellow brown precipitate, as before, and when separated by a filter, washed, dried, ignited, and cooled, 0·320 gr. of a nearly black matter remained. A few drops of nitric acid dissolved this matter; crystals of carbonate of soda were added, and the whole ignited. On dissolving the salts, which were green colored, in water, a yellow solution resulted. The residue was dissolved in nitric, with a little hydrochloric acid, and the solution was decomposed by bicarbonate of ammonia in excess. After the precipitate had been ignited, it weighed 0·099. The carbonate of soda and ammoniacal solutions, contained oxides of uranium and manganese. Neither phosphoric acid, earths, or other metal-

* I here anticipate a doubt, which will arise in the mind of the reader, who has seen it stated that the original solution was saturated with hydrosulphuric acid. Contrary to the general belief, this acid does not decompose a solution of sulphate of lead in hydrochloric acid. The fact is one of importance, as some well waters, in contact with lead, cause this salt to form, and do not then give a precipitate with hydrosulphuric acid.

lic oxides, could be detected. The weight of mixed oxides, by difference, ·320 – ·099 = ·221.

E. On evaporating the fluid, which had given the precipitate of D, with a little oxalate of ammonia, a white precipitate was obtained. Heated with sulphuric acid to bright redness, 0·200 of pure sulphate of lime was left. Binoxalate of ammonia was added to the ammoniacal fluid of C, and by evaporation the white oxalate became granular. Separated by a filter, well washed, and converted into a sulphate, at a red heat, its weight, when cold, was 2·417. These sulphates were dissolved in 2000 grains of boiling water, without any residue. In the solution, ammonia afforded no precipitate; an excess of carbonate of ammonia would remove the whole of the base, as a granular precipitate, insoluble in oxalic acid. The solution, by evaporation, would afford crystals of sulphate of lime. The united weight of 2·417 and 0·200 = 2·617, or the equivalent of 1·087 lime.

F. The insoluble heavy powders of B and C, weighed ·350; treated with hydrochloric acid and water, were boiled; there remained undissolved a white powder, which was nearly pure columbic acid, weighing ·060. Ammonia was added to the solution, and an excess of sulphydrate of ammonia was digested on a black precipitate, which appeared. The fluid filtered off, was evaporated, and the residue calcined. There remained a nearly white peroxide of tin, weighing ·070. The black sulphuret was dissolved in cold diluted nitric acid, and afforded a colorless solution, which could be rendered neutral by ammonia. In it, chromate of potash would give a yellow precipitate; sulphuric acid, a white heavy powder; metallic zinc separated brilliant gray scales of lead. The weight of the sulphate of lead, by difference, was ·220, or the equivalent of ·160 of oxide of lead.

Ten grains of the microlite have thus afforded, of

| | | |
|---|---|---|
| Columbic acid, - - - | A and F, | 7·960 |
| Lime, - - - - - | E, - | 1·087 |
| Oxides of uranium and manganese, | D, - | 0·221 |
| Oxide of iron, - - - | D, - | 0·099 |
| Oxide of lead, - - - | F, - | 0·160 |
| Peroxide of tin, - - - | F, - | 0·070 |
| Loss, - - - - - | - - | 0·403 |

In this analysis, the columbic acid and lime have been carefully separated and weighed. The absence of yttria is proved, not only by trials in C and E, but by repeating the experiments described by Prof. Shepard, on a separate portion of the mineral. Indeed, his own results do not favor the conclusion he adopted.

The columbic acid and lime represent, in their weights, nearly their combining proportions. I do not, however, regard this coincidence as proof, that *all* the columbic acid is really united to all the lime, in the mineral. The recent discovery, by M. Rose, of a columbate of uranium, may be regarded with interest, in this connection.

*Pyrochlore.*

The specimens used in the following analysis, were from the Fredericksvarn locality. The crystals were generally without modifications; but two of them had planes replacing the edges of the octahedron, and exhibited cleavage lines. Their colors varied from wax yellow to dark brown. Sp. gr. 4·203 to 4·221.

*Analysis.*—A. 20 grains lost by heating 0·160, or 0·800 per 100.

B. The fine powder was dissolved in melted bisulphate of potash, and after separating all other substances, there remained 10·590 of pure columbic acid, or 52·950 per 100.

C. After the fluids containing sulphate of potash, and the acids used in washing the columbic acid of B, were neutralized by ammonia, an excess of this alkali was added, and the precipitate which it produced was washed on a filter. The still moist and yellowish brown mass was digested in the sulphydrate of ammonia, which had been used on the columbic acid, for twelve hours. By evaporation, this solution afforded a yellow powder, which, by calcination, became a white oxide of tin, weighing 0·030.

D. The mass on the filter, C, was redissolved in sulphurous acid, containing sulphuric acid, and boiling water was used to wash a few black flocks which remained. On heating the black powder before the blowpipe flame, sulphur exhaled, and the addition of soda caused a globule of lead to separate; converted into oxide, it weighed 0·010. The soda globule left 0·030 of columbic acid. Ammonia was used to again separate the oxides which had been dissolved off the filter from lime, and the solution was removed with the usual precautions, leaving the light yellow oxides on the filter.

E. The filter containing the oxides in D was digested in a solution of oxalic acid; warm water dissolved all the matter it contained. Tartrate of ammonia and pure ammonia were added, till a precipitate which first appeared was redissolved, and the fluid was alkaline. Sulphydrate of ammonia was added, and the vessel closed from the atmosphere. After twenty-four hours, a black precipitate had separated from the fluid. This was collected and calcined; 0·670 of a red brown powder remained. By nitric acid and fusion with carbonate of soda, a green mass resulted. Boiling water gave a greenish yellow solution, containing oxides of uranium and manganese. There was left, after the action of carbonate of soda, a red brown oxide of iron, which weighed 0·470. 0·670 – ·470 = ·200, is the weight of the mixed oxides of uranium and manganese.

F. The fluid from E was evaporated to a dry salt, which was heated in a platina vessel, allowing a current of air. When the carbonaceous matter had been removed, a light yellow oxide remained. When cold, the oxide was white, and possessed the known characters of titanic acid. It weighed 4·040.

G. In the fluid from C, binoxalate of ammonia gave a precipitate, which, converted into sulphate, weighed 7·547. When the fluid from D was treated in the same way, 1·824 of sulphate were obtained. These were dissolved in water, and proved to be pure sulphate of lime, denoting 3·890 of lime. Twenty grains of pyrochlore have thus afforded of

| | | | Per 100. |
|---|---|---|---|
| Columbic acid, - - - | B and D, | 10·620 × 5 | = 53·100 |
| Lime, - - - - | G, | 3·890 | = 19·450 |
| Titanic acid, - - - | F, | 4·040 | = 20·200 |
| Oxide of iron, - - - | E, | 0·470 | = 2·350 |
| Oxides of uranium and manganese, | E, | 0·200 | = 1·000 |
| Oxide of tin, - - - | C, 0·030 } | = ·040 | = 0·200 |
| Oxide of lead, - - - | D, 0·010 } | | |
| Volatile matter lost at redness, | - - | 0·160 | = 0·800 |
| Loss, - - - - | - - | 0·580 | = 2·900 |
| | | 20·000 | |

In the above analysis, I have very briefly described the processes adopted for separating the constituents. I carefully examined the substances enumerated, and have been unable to discover others, which would not have been lost by the method chosen.

The following experiments have reference to the alkaline and volatile constituents. Three grains of pyrochlore were digested in hydrochloric acid, contained in a platina capsule. Over the fluid, a highly polished surface of glass was kept cool by water. The powder dissolved entirely, without causing any loss of polish on the glass. The solution was heated to 212° F., and the excess of acid was allowed to escape. The fluid became turbid, and when dry, a transparent coating lined the vessel. Warm water dissolved the whole of the gum-like coating on the capsule, forming a nearly colorless, transparent solution. Ammonia caused a bulky white precipitate to form, and when separated by a filter, it closely resembled the hydrate of alumina, mixed with magnesia. The entire mass was soluble in very dilute hydrochloric, nitric, acetic, or tartaric acids. When its diluted solution in muriatic acid was treated with a minute quantity of a solution of sulphate of potash, columbic acid in its insoluble state was instantly disengaged, and rapidly subsided. The precipitate, after it had been washed and heated, weighed 1·770, corresponding to 59 per 100 of columbic acid. It was not pure, having carried down titanic acid, lime, &c. The fluid containing an excess of ammonia, from which the first precipitate had fallen, gave a precipitate with oxalate of ammonia. When calcined with sulphuric acid, sulphate of lime, weighing ·390, remained. By evaporating the fluid to a dry mass, and heating the residue, ·308 of chloride of sodium were obtained. On adding an excess of ammonia to the fluid, which had afforded the columbic acid by sulphate of potash, a precipitate was produced. The fluid and precipitate were saturated with hydrosulphuric acid gas. When the precipitate had been separated, the ammoniacal fluid was mixed with oxalic acid; the precipitate calcined with sulphuric acid, was sulphate of lime, weighing ·820. A trace of tin oxide was left, when this salt was dissolved in water. ·820 + ·390 = 1·210, or ·502 of lime. Oxalic acid dissolved the green precipitate containing sulphur, leaving traces of sulphuret of lead. By tartaric acid and ammonia, the titanic acid was retained, while sulphydrate of ammonia precipitated sulphurets of iron, uranium, and manganese. The titanic acid, left after burning off carbon, weighed ·550, and the oxides from the sulphydrate of ammonia precipitates ·020. Three grains, thus treated, gave—

| | | | | |
|---|---|---|---|---|
| Columbic acid, - | 1·770 | or, per 100 parts, | | 59·00 |
| Lime, - - - | 0·502 | " | " | 16·73 |
| Titanic acid, - - | 0·550 | " | " | 18·33 |
| Soda, - - - | 0·169 | " | " | 5·63 |
| Oxides iron, uranium, &c., | 0·020 | " | " | 0·70 |
| Volatile matter, - | 0·002 | " | " | 0·80 |
| | 3·013 | | | 101·19 |

It was after this analysis had been finished some months, that a friend showed me the corrected results, published by M. Wöhler, as obtained in analyses of the pyrochlore from Maisk and Brevig. His results had shown the pyrochlore from these localities to be a columbate of lime, associated by crystallization with another mineral; the lime base being in part replaced by thorina and oxide of cerium.

I consider the chemical evidence as fully confirming the conclusions which Mr. Teschemacher had arrived at before it was obtained. The numbers which I have given as the weights of the constituents of the Fredericksvarn variety, lead to a chemical formula; but for reasons which will appear hereafter, I do not feel confident that the combining weight of columbic acid has been accurately determined.

Roxbury Laboratory, Dec. 4th, 1843.

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## Art. XX.—*On the A state of Columbic Acid;* by Augustus A. Hayes.

In giving an account of an analysis of microlite, I alluded (*ante*, p. 159) to an error I committed, in mistaking columbic, for titanic acid. Pursuing the inquiries, I found the cause of the mistake to be some hitherto unknown characters of the columbic acid. The subject had been studied and results communicated to scientific friends, before the following abstract, from a paper by M. Wöhler was shown me. I give the abstract, as found in Berzelius's Report for 1841.—"Pure columbic acid, when heated nearly to the temperature of redness, becomes yellow; its white color being restored on cooling. When it is heated in a current of hydrogen, it becomes of a brownish black color, losing slightly in weight, and seems to pass to the state of a columbate of oxide of columbium, like the corresponding compound, tungsten. Columbate of ammonia gives the same compound, when heated to redness in close vessels. In decomposing by bisulphate of potash, at a red heat, a columbic mineral, there is obtained a columbic acid, containing sulphuric acid; which is not dissolved by digesting the mass in water, nor by the action of concentrated hydrochloric acid, used in washing it; but if left to digest in hydrochloric acid, and we afterwards add water, it dissolves. Boiling precipitates anew the columbic acid from the solution. Sulphuric acid, or a sulphate, precipitates it almost entirely, in the form of a white heavy powder, from which the sulphuric acid is not driven off by simple calcination; but the columbic acid is completely freed from sulphuric acid, by heating the combination in an atmosphere of carbonate of ammonia. M. Wöhler considers the precipitation of columbic acid, by sulphuric acid, as a property characteristic of columbic acid. Columbic acid combined with sulphuric acid, and still moist, dissolves in caustic potash or soda, and is precipitated from such solutions by acids. Sal ammoniac precipitates a large part, but the precipitate is a columbate of ammonia. The moist sulphate of columbic acid, mixed with concentrated hydrochloric acid, in contact with zinc, produces a beautiful blue solution, which afterwards becomes brown, remaining clear. Ammonia, added in sufficient quantity to retain the oxide of zinc in solution, precipitates a hydrate, of a brown oxide of columbium, which becomes white, under the influence of air. Hydrochloric acid, with the aid of zinc, does not dissolve columbic acid, which has been dried; but the latter becomes blue. It remains colorless, if it has been calcined. This does not prove that it contains tungsten, for the acid which becomes blue does not exhibit this color, when heated by the blowpipe and reducing flame, with phosphoric salt. In calcining a mixture of columbic acid and sugar, in a covered crucible, reducing the product to a fine powder and heating it to redness in a current of dry chlorine; there is obtained a chloride of columbium, which possesses entirely different properties from the chloride we obtain in causing a current of chlorine to pass over columbium. M. Wöhler considers the product of this operation, as representing the combination of columbic acid and chloride of columbium, corresponding to the analogies of chrome, tungsten and molybdena. There is obtained a white sublimate, which forms vapors in the air, and which may be sublimed again, without decomposition and without becoming fused. The gas is colorless and condenses in the form of a silky mass, radiating and converging to a point. This combination is sometimes yellow; it partially melts and gives a yellow gas, as if it were mixed with pure chlorine. It dissolves in water, depositing columbic acid, in the form of jelly; which contains chloride of columbium, and which gives hydrochloric acid by calcination. The sublimate produces a clear solution with hydrochloric acid; it may be heated to boiling, without forming a precipitate, but when by evaporation it arrives at a certain concentration, it deposits a white precipitate, which dissolves anew by the addition of a large quantity of water. It would appear that this sublimate contains columbic acid, in a different modification from that of the ordinary chlorides of columbium. This modification corresponds to the two different modifications of oxide of tin. Sulphuric acid precipitates columbic acid from the solution, even when it is found under this modification." These observations of M. Wöhler, I deem of much importance, to those engaged in analytical inquiries. The most trustworthy of the indications of the existence of titanic acid, in a solution, is the production of a blue color and precipitate by zinc. The development of a yellow color by heat, has been considered a distinctive property of titanic acid. The compounds of columbic acid have been considered insoluble in hydrochloric acid.

If we treat pyrochlore with pure hydrochloric acid, it readily dissolves, although from 50 to 80 parts per cent. of its weight are columbic acid. By evaporation, the solution becomes turbid, afterwards milky, and finally deposits a white opake salt, precisely as follows from the same treatment of a solution of a titanate. If the evaporation has been carried on at a moderate temperature, the salt is crystalline in appearance and remains soluble. Boiling the solution, causes the precipitate to become nearly insoluble in water, but the addition of hydrochloric acid effects a solution. When the salt has been dried, it loses its opake appearance, and becomes a transparent glass-like mass. Water acidulated with hydrochloric acid, readily dissolves the salt. Instead of pyrochlore, we may use pure columbic acid, which has not been heated, and a solution of titanic acid, or oxide of uranium, in hydrochloric acid. The hydrate of columbic acid dissolves freely, if it be mixed with either oxide of uranium, or titanic acid. In such a solution, it has assumed what may be called its A state. Ordinary columbic acid dissolves in acids and oxalates, to a certain extent, but such solutions have not the characters that those of the acid in its A state exhibit. *From an electro-negative or acid state, and without any apparent change of composition, it takes a positive or basic state.* It may be precipitated by carbonates of soda and potash; by pure and carbonate of ammonia, as a white hydrate, closely resembling alumina. This hydrate dissolves in most of the acids freely. A solution in hydrochloric acid, much diluted, had the following reactions: With sulphuric acid, a white precipitate, which redissolves in an excess of the precipitant. Nitrate of potash, no change of appearance. Sulphate of ammonia, a white precipitate, soluble in acids. Sulphate of soda, the same; the precipitate is less soluble. Nitrate of soda, no change apparent.

The most remarkable action follows the addition of sulphate of potash. A solution containing only a minute quantity of this salt, annihilates as it were the A state of the columbic acid, and changes it to its ordinary state. At the instant of acquiring its usual acid relation to the substances present, it precipitates and carries down with it some portion of them in an insoluble state. If a solution of columbic acid in its A state, be boiled in a flint glass vessel, and afterwards a drop of sulphuric acid or a sulphate is added, a precipitate denoting the presence of sulphate of potash falls. When the columbic acid has been prepared by heating a native compound, with 6 or 8 parts of bisulphate of potash, it always contains sulphuric acid. A quantity of bisulphate equal to 12 or 15 times the weight of the mineral being used, the acid is readily obtained pure.

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## Art. XXI.—*Hints on the Iceberg Theory of Drift*;—in a letter from Mr. Peter Dobson to Prof. Edward Hitchcock.

### *Extract of a Letter from Prof. Hitchcock.*

Messrs. Editors,—You will recollect that in Mr. Murchison's Anniversary Address before the London Geological Society, for 1842, he gives credit to Mr. Peter Dobson of Vernon in Connecticut, as "the original author of the best glacial theory;"* and in proof quotes a paper by Mr. Dobson in the Journal of Science for 1826. In looking over my papers lately, I found a letter from Mr. Dobson on this subject, written six years ago, which I send you, in the hope that you will publish it; because it carries out his views more minutely than does the paper referred to by Mr. Murchison; and these views are with him evidently original. I am the more inclined to do this, as I fear, from not finding any

* See this Journal, Vol. xliii, p. 200.

mark to that effect upon it, that I never answered the letter; and if so I would gladly do something to atone for a seeming want of courtesy. I must say, however, that my first ideas of the joint action of ice and water in producing the phenomena of drift, were derived from the views of Sir James Hall concerning diluvial phenomena in Scotland; for he introduces floating ice as one of the agents; but he gives no such distinct ideas of this agency as Mr. Dobson and other recent advocates of the iceberg theory do.

Vernon, Nov. 15, 1837.

Mr. Hitchcock,—

*Sir*—I have read several good articles in the Biblical Repository written by you on geological subjects, and I have now before me the one on "historical and geological deluges." I have read what I have had an opportunity of seeing on these subjects, and for a number of years I have been noticing some facts, which I thought might throw some light on this interesting science; and as there is one physical fact that is common in this region that does not appear to be noticed by you, I take the liberty to address you on the subject.

It is common to find bowlders of red sandstone in this neighborhood, on and near the surface, as well as deep in the diluvial masses of earth, that have been partially rounded by attrition, and afterwards worn on one side rather flat, by a motion that has kept the bowlder in one relative position, as a plane slides on a board in the act of planing. Some of the bowlders are worn, and scratched so plain, that there is no difficulty in pointing out which side was forward, in the act of wearing, for it sometimes happens that there are minerals of quartz and feldspar in them, and if they happen to be in the part that has been worn, these minerals being harder have protected some of the softer part of the stone, so as to form a ridge from the mineral, as a wooden pin would, driven into the plank of a stone drag, in that part that is exposed to be worn by sliding on the ground.

Some of these bowlders are so nearly round, that a powerful current, sufficient to move them, would not cause them to slide but to roll; yet they have been made to slide so as to receive distinct scratches, and the projecting minerals, I have no doubt, have done some scratching on the rocks in place. Many of these bowlders when dug out of the earth have a freshness of appearance, as if they had been recently worn, and the last act of wearing seems to have been sliding. I cannot account for the appearances on these worn bowlders, without their being enveloped in ice, and moved in ice by currents of water.

In the 66th number (Vol. xxxii) of the American Journal, edited by Mr. Silliman, is an article by Mr. Redfield on currents on the coast of this continent, and at page 351 he says: "It is doubtless true that the great stream of ice is brought by the Labrador current within the dissolving influence of the Gulf Stream; and I may here remark that it is not improbable that the Grand Bank owes its origin to the deposits which have resulted from the process for a long course of ages." (See also the note on the same page.)

I crossed the Grand Bank in April, 1809, and then there was ice spread over from ten to twelve degrees of longitude, commencing on the east side with small fragments in close contact, and as it extended westward it kept increasing in size, so that half the extent on the west side was large icebergs, say from twenty to forty feet high above the water, and a few miles apart. How far the ice extended north and south I have no means of knowing, but I saw so much ice, that when I have seen it mentioned that the icebergs seen almost every spring by ships crossing the Grand Bank, originated by fragments of ice breaking off from the coast of Davis's Straits, I have always considered the cause not equal to the effect, for in April any year all north of Hudson's Straits must be locked up by solid ice.

The article "Ice" in the Edinburgh Encyclopedia says, that in the north of Europe, "ice sometimes attaches itself to anchors in such quantities, as to raise them to the surface by its buoyancy;" and again, that "ice forms at the bottom of great thickness before it rises, and then brings up with it, not only earth and gravel, but stones of large size;" and many more facts of a similar nature.

Now why may not ice attach itself to bowlders and other loose materials at the bottom of the ocean, off the Labrador coast, in such quantities as to buoy up stones and other loose matter; and be floated along in the polar current, increasing in bulk by freezing after they rise to the surface; and in this way account for so much ice being seen annually, so early as April and May, on the Grand Bank?

It appears to me, that there are causes now in action on the northeast coast of this continent, that are producing effects similar to what has been done by diluvial currents on the surface of New England.

If you have not had an opportunity of seeing worn bowlders, such as I have described, I should be glad to have the pleasure of showing you some. Respectfully yours, &c.

PETER DOBSON.

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ART. XXII.—*Notice of Travels in the Alps of Savoy, and other parts of the Pennine Chain, with observations on the phenomena of Glaciers;* by JAMES D. FORBES, F. R. S., Sec. R. S. Ed., Cor. Mem. of the Institute of France, and Prof. of Nat. Phil. in the Univ. of Edinburgh.*

THE beautiful work of Prof. Agassiz on the Glaciers, with its fine illustrations, produced so vivid and deep an impression, that the no less splendid volume of Prof. Forbes, finds the public mind already awakened, informed and eager for additional information, but not disinclined to receive any new theoretical views that promise to be stable; it cannot fail therefore to excite much attention, both on account of what it affirms and what it denies. The great work of the distinguished Swiss naturalist on the study of the Glaciers, as well as his labors in other departments of science, with the discussions which they have excited, we and our correspondents have frequently noticed.† In turning therefore to a successor and a friendly rival in the ice-fields of the Alps, we find new facts and new theoretical views, in a department which appeared to have been almost exhausted by the labors of De Saussure, Hugi, Necker, Escher, Lardy, Zumstein, Venetz, Charpentier, Studer, Rendu, and above all by those of Agassiz.

The travels of Prof. Forbes, are contained in a volume of 424 pages royal octavo, closely printed on beautiful paper. They are illustrated by nine excellent lithographic views of glaciers and ice-girt mountains and by two topographical maps, one large and folded; also by nine topographical sketches inserted in the body of the pages.

The text is divided into twenty one chapters and followed by an appendix. This work contains ample and exact details in topography,

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* Received through the kindness of the publishers, Adam & Charles Black, Edinburgh; and Longman, Brown, Green & Longman, London.

† See this Journal, Vol. XLI, p. 191—194; Vol. XLII, p. 346; Vol. XLIII, p. 390; Vol. XLIV, p. 146; Vol. XLV, p. 324, &c.

many new and valuable engineering observations taken with accurate instruments, and often made in painful or dangerous circumstances, among the eternal snows and treacherous ice-cliffs and glaciers of the Alps. It abounds with daring and hazardous adventures, contains notices of occasional catastrophes that have befallen less fortunate explorers; presents interesting discoveries, with new deductions, and is clothed in a style and diction entirely in keeping with the beauty and grandeur of the subject. If a literary reader would sometimes tire amidst the almost endless details, on Alpine snows, crevasses and glaciers, he would be relieved, at short intervals, by unrivalled beauty of description and sublime sketches of those scenes which are forever arrayed in a wild and terrible grandeur. We have perused the work with intense pleasure and large instruction, and with a conviction, if possible increased at every step, of the great energy of the action of glaciers in furrowing and scratching and polishing those rocks upon which they repose, if repose it can be called where there is no rest, since the glaciers are always advancing in immense fields and rivers of ice upon the country below; and were it not, that the melting at the lower end of the ice-cliffs prescribes limits to their extension, it is not easy to see why they would not eventually usurp dominion over a large portion not only of the polar but of the temperate zones of the earth, which they are supposed by Agassiz to have formerly covered.

Prof. Forbes accords with all other writers on the subject that "the snow which falls on the summit of the Alps, becomes converted into ice by successive thaws and congelations," but the explorers who have published their views have not been agreed as to the immediate cause of the descent of these frozen masses down the vallies and towards the plains. Dilatation by the freezing of water, and gravitation, include the principal theories.

The author denies that the descent of the ice is due to dilatation, while this cause, as he believes, contributes to swell the volume of the ice upward or at right angles to the bed of rock on which it lies. Gravitation, as he avers, could never move downward a rigid inflexible field of ice upon a rocky and uneven bottom, and often confined between projecting buttresses, where the approximation of mountain cliffs narrows the space into a gorge or strait, in the manner in which rivers are pent up by opposing walls.

The declivity of the *Mer de Glace* averages only 9°, and in many parts hardly equals that of many hills over which loads are drawn by animals; in many cases it does not exceed 5°—less than the slope of the great Simplon, which is a road for artillery, and often it falls far short of that amount; this fact renders it highly improbable, not to say impossible, that a firm field of ice should slide down such a gentle declivity, especially against all the obstacles that have been named, and over the jagged and rough projections of rocky defiles. It is found that the freezing of the water that percolates through the fissures of the ice penetrates but a small distance in summer, and in the winter, when the dilatation by freezing is the greatest, the motion of the glacier downward is the least, whereas upon the dilatation theory it should then be the greatest. In the summer season the motion is the most rapid, and then there is no internal congelation, and very little upon the surface. At seven thousand nine hundred feet above the sea, on the Montanvert, in the month of September, 1842, although in severe weather, the ice was, as usual, charged with water, except on the surface, where it was dry, but a little way down water was easily obtained by breaking the ice in a pool frozen over under a stone. The progress of the glacier downward was always retarded by the increase of cold, and augmented by a thaw. The snows which cover the ice appear to preserve in it an equality of temperature, as they do in the ground; for Prof. Agassiz himself found the ice at all depths within a fraction of 32°.

The supposed sliding motion of a solid mass of ice by gravity is inconsistent with the rapid progress of the middle of the mass, (taken in the direction of its length,) for it has been distinctly proved by Prof. Forbes, that the sides next to the rocky walls move the most tardily, and in no part of the summer is the ice frozen fast to the mountain sides.

It has been supposed by Saussure and others, that the heat of the earth causes a fusion of the bottom of the glaciers, lubricating their path, and thus facilitating their motion; but this effect must be extremely small, and has been considered, upon the theory of Fourier, equal only to melting a quarter of an English inch of ice in the space of a year. It would, therefore, be entirely inadequate to smoothing off the nether asperities of the glacier, which must impede its motion. Prof. Forbes, after setting aside the previous theories, announces his own, as follows: "A GLACIER IS AN IMPERFECT FLUID, OR A VISCOUS BODY, WHICH IS URGED DOWN SLOPES OF A CERTAIN INCLINATION, BY THE MUTUAL PRESSURE OF ITS PARTS," (by gravity, of course.) This is illustrated by the motion of a moderately thick mortar, or of melted tar, or treacle, down an inclined plane, fashioned in the form of a trough, and these materials will be found to be governed by their own viscosity and the friction on the channel.

"*That glaciers are semi-fluid is not an absurdity.*" Even water is not quite mobile; it requires a slope of 6 inches to a mile, or $\frac{1}{10000}$ part, to make it run freely, while some other fluid might require a slope of $\frac{1}{1000}$, and many bodies may be heaped up at an angle of many degrees before their parts will begin to slide over each other.

"That a substance apparently solid may, under a great pressure, begin to yield; yet that yielding or sliding of the parts over one another may be quite imperceptible upon the small scale, or under any but an enormous pressure." A column of the body itself is the source of the pressure—a column often of several hundred or thousand feet in height,—the origin and termination of many of the largest of the glaciers having not less than four thousand feet of elevation between their origin and end. Were the glaciers suddenly converted into water, the bottom would move with a force of forty-four millions of feet, or eight thousand three hundred and thirty-three miles in twenty-four hours; whereas the velocity of a glacier is only about two feet in that time, implying a pressure, however, quite sufficient to produce the effect of slow descent. "A glacier is not coherent ice, but is a granular compound of ice and water, possessing under certain circumstances, especially when much saturated with moisture, a rude flexibility, sensible even to the hand." Glaciers do collapse, and thus choke up and close their own *crevasses* (fissures) with their plastic substance. A glacier contracts when embayed by rocks, and presses through a narrower channel than that by which it entered, and having passed the gorge into a wide valley, it spreads itself out wider, as a viscous substance would do.* *The motion of a glacier resembles that of a viscous fluid;* the velocity varies with the slope; the surface, especially the middle of the surface, moves fastest.

The higher and central parts of such a mass will move nearly together, while the bottom and sides will be most influenced by the friction. The mean velocity of the entire stream is the mean between that of the top and bottom. The flow will vary with the temperature; hot water runs out of an orifice more rapidly than cold. All these circumstances are imitated by the glacier. The centre of a glacier moves faster than the sides; the top than the sides and bottom. Glaciers slide over their beds in consequence of the particles of ice sliding over each other; the motion of the superficial parts pulling along the inferior. A glacier descending into a valley, is like a body pulled asunder and stretched, and not like a body forced on by superior pressure alone. "The glacier, like a stream, has its pools and its rapids. Where it is embayed by rocks, it accumulates; its declivity diminishes, and its velocity at the same time. When it passes down a steep, or issues by a narrow outlet, its velocity increases."

"*The veined structure of the ice is a consequence of the viscous theory.*" A viscous stream presents wrinkles, or curvilinear arrangements of the floating matter, accompanied by a crumpling, or inequality of the surface. The dirt bands described very minutely by Prof. Forbes, are at-

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* An opinion first brought prominently forward by M. Rendu, now Bishop of Annecy.

tributed to this cause. The dirt and small stones are detained in those wrinkles or curved lines, which are soft and oozy with water, and thus the accumulated lines of dirt remain and exhibit a banded succession of earthy materials. The author has elucidated and confirmed these views by actual experiments made upon the flow of viscous and tenacious matters, which he finds to correspond with the great Alpine exhibitions. Bishop Rendu, of Annecy, has insisted upon the plasticity of the ice; moulding itself to the endlessly varying forms and sections of its bed, and he maintained that the centre of the ice stream moved the fastest. Captain Hall says, " When successive layers of snow, often several hundred feet in thickness, come to be melted by the sun and by the innumerable torrents which are poured upon them from every side, to say nothing of the heavy rains of summer, they form a mass not liquid, indeed, but such as has a tendency to move down the highly inclined faces on which they lie, every part of which is not only well lubricated by running streams resulting from the melting snows on every side, but has been well polished by the friction of antecedent glaciers. Every summer, a very slow but certain advance is made by these huge, sluggish, and bulky, half snowy, half icy accumulations."

Prof. Forbes justly remarks that no one has a right to assume the plasticity of the materials of glaciers as the foundation of a theory, until the fact has been proved by decisive observations and experiments. " These observations have been made, and the result is, the viscous or plastic theory of glaciers, as depending essentially on the three following classes of facts"—first ascertained by himself in 1842, the proofs being contained in the work now under consideration. For those details of proofs we have not room, but they are believed to sustain the following conclusions:

1. " That the different portions of any transverse section of a glacier move with varying velocities, and fastest in the centre."

2. " That those circumstances which increase the *fluidity* of a glacier, namely, heat and wet, invariably accelerate its motion."

3. " That the structural surfaces, occasioned by fissures which have traversed the interior of the ice, are also the surfaces of maximum tension, in a semi-solid or plastic mass, lying in an inclined channel."

The glaciers undergo a surprising depression during the summer, and a correspondent elevation in the winter. In the summer, the streams flowing beneath the glacier contribute to waste it; the warmer earth melts the inferior surface, and the lower extremity of the glacier, where it touches the fields, moves faster than the upper, thus drawing it out, and thinning it mechanically. The difference of level between summer and winter is sometimes twenty to twenty-five feet, and the depression of summer is certainly made up in the winter and spring. This may be "partly owing to the dilatation of ice during winter, by the congelation of the water in its fissures, producing at the same time the veined structures." The glacier is, indeed, very far from being frozen to the bottom during winter, for a great portion of the icy mass is still plastic; but the congelation extends to a considerable depth, and produces the usual effects of expansion. This cause alone appears, however, to be inadequate to the effect, and the author attributes the elevation of the surface mainly to the diminished fluidity of the glacier in cold weather, which retards the motion of all its parts, and especially of those that move most rapidly in summer. The ice is more pressed together, and less drawn asunder; the crevasses are consolidated; "while the increased friction and viscosity cause the whole to swell, and especially the inferior parts, which are the most wasted."

"Such a hydrostatic pressure, likewise, tending to press the lower layers of ice upwards to the surface, may not be without its influence upon the (so called) rejection of blocks and sand by the ice."

It is well known that masses of stone, when below, rise to the surface, and those on the surface remain there, and continue age after age to travel downwards towards the plains. Prof. Forbes, although regarding the views expressed above as only conjectural, has, however, no doubt that the convex surface of the glacier (which resembles that of mercury in a barometer tube) is due to the hydrostatic pressure acting upwards with most energy near the centre. "Exactly contrary is the case in a river, where the centre is always the lowest; but that is on account of the extreme fluidity, so that the matter runs off faster than it can be supplied." This view is believed not to be inconsistent with the former supposed great extension of glaciers, even from Mount Blanc to the Jura mountains, of Geneva, more than fifty miles, in which case they must have moved "with a superficial slope of one degree, or in some parts even of a half or a quarter of that amount, whilst in existing glaciers, the slope is seldom or never under three degrees. The declivity requisite to insure a given velocity, bears a simple proportion to the *dimensions* of a stream. A stream of twice the length, breadth, and depth of another, will flow on a declivity half as great; and one of ten times the dimensions, upon one-tenth of the slope."

The author finishes his view of the philosophy of the glaciers with the following beautiful reflections: "Poets and philosophers have delighted to compare the course of human life to that of a river; perhaps a still apter similitude might be found in that of a glacier. Heaven-descended in its origin, it yet takes its mould and conformation from the hidden womb of the mountains which brought it forth. At first, soft and ductile, it acquires a character and firmness of its own, as an inevitable destiny urges it on in its downward career. Jostled and constrained by the crosses and inequalities of its prescribed path, hedged in by impassable barriers which fix limits to its movements, it yields to its fate, and still travels forward, seamed with the scars of many a conflict with opposing obstacles. All this while, although wasting, it is renewed by an unseen power,—it evaporates, but is not consumed. On its surface it bears the spoils which, during the progress of existence, it has made its own;—often weighty burdens, devoid of beauty or value—at times, precious masses, sparkling with gems or with ore. Having at length attained its greatest width and extension, commanding admiration by its beauty and power, waste predominates over supply, the vital springs begin to fail; it stoops into an attitude of decrepitude; it drops the burdens, one by one, which it has borne so proudly aloft; its dissolution is inevitable. But, as it is resolved into its elements, it takes all at once a new and livelier and disembarrassed form;—from the wreck of its members, it arises 'another, yet the same.' A noble, full-bodied, arrowy stream, which leaps rejoicing over the obtacles which before had stayed its progress, and hastens through fertile valleys towards a freer existence and a final union in the ocean, with the beautiful and the infinite."

Prof. Forbes spent many summers in exploring the Alps, encouraged the more to continue and repeat his arduous and adventurous journeys, because it has now become so easy to arrive promptly at the scene of one's explorations.

"The modern facilities for travelling extend not only to England, France, Germany, and what in former days was called *the grand tour*, but gentlemen now walk across Siberia with as little discomposure as ladies ride on horseback to Florence. Even the Atlantic is but a highway for loungers on the American continent, and the overland route to India is chronicled like that from London to Bath. The desert has its posthouses, and Athens has its omnibusses."

He appears strongly impressed by the belief that even in the countries most visited and explored, much more remains unknown than has been described, and "it is not too much to say, that the natural history of a great part of the chain of the Alps, the most instructive and the grandest theatre of natural operations in Europe, is in this predicament." Although the work of Prof. Forbes is avowedly a book of travels, its principal aim "is to illustrate the physical geography of a particular district, in one of the most frequented regions of the Alps; and more especially to arrive at results of a definite kind respecting the natural history of the glaciers, those great masses of ice which so generally attract the casual, though only the casual, notice of travellers." It is now a good many years since our author projected these travels, having visited the Swiss Alps in early youth, and having carefully refreshed and strengthened his recollections by successive visits during a part of ten summers, to almost every district of the Alps between Provençe and Austria. He has crossed the principal chain of the Alps twenty-seven times, generally on foot, by twenty-three different passes, and he has intersected the lateral chains in many directions. Unlike De Saussure, who frequently in his annual journeys travelled with ten or twelve men, as attendants, and four to six mules of burden—or Prof. Hugi, of Soleure, who often had with him twelve to fifteen companions and guides, largely paid, the Scotch professor pursued his inquiries almost alone. He employed neither draughtsman, surveyor, or naturalist. Every thing that it was possible to do, he executed with his own hands, noted the result on the spot, and extended it as speedily as possible afterwards. His only assistant was Auguste Balmat, a very intelligent and worthy guide of Chamouni. The work of Prof. Forbes is sustained by very recent observations. He spent the latter part of June, 1842, at the Montanvert, (Chamouni,) the first half of July on the southern side of Mount Blanc, and in Piedmont. Returning by the Montanvert, by the Col du Geant, he continued his experiments on the *Mer de Glace*, until the ninth of August. He then, in company a part of the time with Prof. Struder, passed a month in visiting Monte Rosa and the adjacent country, and finished September on or near the glacier at Chamouni.

His last date, in a communication from his faithful guide, Balmat, is even as late as June 8th, 1843—six months from this date, (December 8th, 1843.) The information relates to the descent of the ice near the Montanvert, which during the preceding nine months had been at the rate of nearly fifteen inches for twenty-four hours.

*Snow line and glaciers.*—High mountains are in every zone covered with snow ;—the atmosphere grows colder and colder the higher we ascend into it, and therefore in ascending a high hill or mountain we pass through a succession of climates. "While the plains are covered with the verdure of summer, eternal winter reigns upon the summits; and thus the stupendous ranges of the Himalaya or the Andes present, in one wonderful picture, all the climates of the earth, from the tropics to the poles."

At the equator, the snow is permanent at 16,000 feet, a little more than three miles above the level of the sea. In the Swiss Alps, the snow line is 8,700 feet high. In very high latitudes, the snow line comes down to the sea level ;—in such countries snow is the natural covering of the earth, and the very soil is frozen to an increasing depth. In the warm season snow melts in every climate; and if the snow which falls in one season is just melted and no more, then the snow line is stationary—if all that falls is not melted, then this line advances—and if more is melted, then it recedes.

But what is a glacier? "A snow-clad mountain is not a glacier." "The common form of a glacier is a river of ice filling a valley, and pouring down its mass into other valleys still lower. It is not a frozen ocean, but a frozen torrent. Its origin or fountain is in the ramifications of the higher valleys and gorges, which descend among the mountains perpetually snow-clad. But what gives to a glacier its most peculiar and characteristic feature, is, that it does not belong exclusively or necessarily to the snowy region already mentioned. The snow disappears from its surface in summer as regularly as from that of the rocks that sustain its mass. It is the prolongation or outlet of the winter-world above; its gelid masses protruded into the midst of warm and pine-clad slopes and green sward, and sometimes reaching even to the borders of cultivation. The very huts of the peasantry are sometimes invaded by this moving ice, and many persons now living have seen the full ears of corn touching the glacier, or gathered ripe cherries from the tree, with one foot standing on the ice."

"Thus much, then, is plain—that the existence of the glacier in comparatively warm and sheltered situations, exposed to every influence which can insure and accelerate its liquefaction, can only be accounted for by supposing that the ice is pressed onwards by some secret spring,—that its daily waste is renewed by its daily descent,—and that the termination of the glacier, which presents a seeming barrier or crystal wall immovable, and having usually the same appearance and position, is, in fact, perpetually changing—a stationary form, of which the substance wastes—a thing permanent in the act of dissolution." The thawing of the ice from the heat of the ground,—the flow of springs beneath,—the infiltration of rain and snow water from the heat of the sun, and the fusion of the ice by the rain, conspire to produce turbid rivers below the ice, and to excavate enormous arches and caverns.

Most of the water appears to be derived from the sun and the rain; and hence the Rhine and other great rivers supplied by Alpine sources, have their greatest floods in July, and not in spring and autumn, as would be the fact if they were fed by rain alone. The swell and roar of the torrents are far greater at noon than at evening, and in the morning are still less remarkable.

"The lower end of a glacier is usually very steep and inaccessible; sometimes the glacier falls in an icy cascade a thousand feet—the inclination being greatest at the beginning and termination, and least in the middle. The glaciers are covered with blocks of stone that have fallen from the cliffs, torn off by the expansion of freezing water, and precipitated by gravity as the sun dissolves the icy bands that held them fast to their native cliffs. As the glacier moves downward, the blocks are borne along in continuous lines on both sides, thus forming the moraines, as they are called. The geology and mineralogy of inaccessible precipices, are thus learned by inspecting the masses that have certainly fallen from them."

"A glacier is an endless scroll, a stream of time, upon whose stainless ground is engraved the succession of events, whose dates far transcend the memory of living man." "Assuming roughly the length of a glacier to be twenty miles, and its annual progression five hundred feet, the block which is *now* discharged from its surface in the terminal moraine, may have started from its rocky origin in the reign of Charles I! The glacier history of two hundred years is revealed in the interval, and a block larger than the largest of the Egyptian obelisks, which has just commenced its march, will see out the course of six generations of men ere its pilgrimage too be accomplished, and it is laid low in the common grave of its predecessors."

The mean or middle portion of the glacier, is a gently sloping torrent, from half a mile to three miles wide—more or less undulating on its surface, and more or less broken up by crevasses of a few inches to many feet in width, and sometimes extending across the glacier, and to a frightful depth.* They often impede, and sometimes arrest the traveller, even when they appear trifling at a distance; and they abound with hollows, into which innumerable rills are precipitated, and combine into large streams—thus establishing an extensive drainage, often attended by bold and beautiful cascades. As the glaciers rise in winter, they elevate the blocks of stone with them, and in consequence of their sliding or rolling off laterally, they are often lodged on high ledges, where they are left when the glacier sinks;—they frequently fall also over the sides of the glacier next to the rocky barrier, or they are tilted into the crevasses and hollows, and by the motion of the icy flood are ground and chafed, losing their angular form, and producing grooves and scratches parallel to the motion of the ice.

Two glacier streams sometimes unite and become confluent, and each bearing along its line of rocks, two lines may thus combine into one—producing medial or middle moraines composed of different ruins, while the exterior line of each continues distinct.

It is obvious that by the confluence of several glaciers, several middle moraines may be produced. "The moraines remain upon the surface, and are rarely dissipated or engulphed; on the contrary, the largest stones are set on a conspicuous preëminence—the heaviest moraine, far from indenting the surface of the ice, or sinking among its substance, rides upon an icy ridge as an excrescence, which gives to it

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* Nine hundred feet on Mont Blanc, as recently observed by Dr. Grant, an intelligent American traveller.—Eds.

the character of a colossal backbone of the glacier, or sometimes appears like a noble causeway, fit indeed for giants, stretching for leagues over monotonous ice, with a breadth of some hundreds of feet, and raised from fifty to eighty feet above the general level. Almost every stone, however, rests on ice ;—the mound is not a mound of debris, as it might at first appear to be. Nor is this all. Some block of greater size than its neighbors, covering a considerable surface of the ice, becomes detached from them, and seems shot up upon an icy pedestal. This apparent tendency of the ice to rise wherever it is covered by a stone of any size, results from the fact, that its surface is depressed every where else by the melting action of the sun and rain,—the block like an umbrella protects it from both,—its elevation measures the level of the glacier at a former period, and as the depression of surface is very rapid—amounting to a foot per week during the warm months of summer—the ice, like the fields, puts forth its mushrooms, which expand under the influence of the warm showers, until the cap becoming too heavy for the stalk, or the centre of gravity of the block ceasing to be supported, the slab begins to slide, and falling on the surface of the glacier, it defends a new space of ice, and forthwith begins to mount afresh. These appearances are called Glacier Tables, and their origin was perfectly explained by Saussure."

Sand washed into the hollows, eventually forms a protection from farther melting, and the hollows, by the melting of the surrounding ice, form cones of great regularity, twenty or thirty feet high, and eighty or one hundred in circumference.

The snow as regularly disappears and melts from the surface of the glacier, as it does from the surface of the ground in its neighborhood ; but it disappears more tardily as we ascend, and at length we reach a point where it never disappears at all, and this is the snow line upon the glacier. The term *névé*, used by modern glacialists, means that part of the glacier which is covered with perpetual snow ; it is where the surface of the glacier begins to be annually renewed by the unmelted accumulation of each winter, and the stratification is entirely obliterated as the *névé* passes into complete ice.

The icebergs of the polar seas are chiefly *névé*, or consolidated snow. It is far more easily fractured than ice, and also more easily thawed and water-worn, " hence the caverns in the *névé* are extensive and fantastical, often extending to a great distance under a deceptive covering of even snow, which may lure the unwary traveller to destruction. Sometimes through a narrow slit or hole opening to the surface of the *névé*, he may see spacious caverns of wide dimensions, over which he has been ignorantly treading, filled with piles of detached ice-blocks, tossed in chaotic heaps, whilst watery stalactites—

icicles of ten or twelve feet in length—hang from the roof, and give to these singular vaults all the grotesque varieties of outline which are so much admired in calcareous caverns, but which here show to far greater advantage in consequence of their exquisite transparency and lustre, and from being illuminated, instead of by a few candles, by the magical light of a tender green, which issues from the very walls of the crystal chambers."

"Considering then the glaciers as the outlet of the vast reservoirs of snow of the higher Alps—as icy streams moving downwards, and continually supplying their own waste in the lower valleys, into which they intrude themselves like unwelcome guests, in the midst of vegetation and to the very threshold of habitations—it is a question of the highest interest to explain the cause of this movement of the ice.

"The glacier moves on, like the river, with a steady flow, although no eye can see its motion; but from day to day, and from year to year, the secret silent course produces the certain slow effect; the avalanche feeds it and swells its flowing tide; the mightiest masses which lightning, or the elements roll from the mountain side upon its surface, are borne along without pause; when the glacier advancing beyond its usual limit, presses forward into the lower valleys, it turns up the soil, and wrinkles far in advance the green sward of the meadows, with its tremendous ploughshare; it brings amongst the fields the blasts of winter, and overthrows trees and houses in its ruthless progress; no combination of power and skill can stay its march, and who can define the limits of its aggression! Its proud waves are however stayed, and by causes as mysterious as those of its enlargement; it retreats year by year within its former limits; but where the garden and the meadow were, it has left a desolate spread of ruin, like the fall of a mountain, which never again may be tilled, and over which for at least half a century, not even a goat shall pick the scanty herbage."

The transporting power of glaciers is wonderful—superior to that of any other power—unless it be that of icebergs, those floating glaciers, which however exhibit only another mode of the same action.

Vast masses of primitive rocks, that have apparently undergone little wear and tear in travelling, are found upon secondary or alluvial surfaces, at a great distance from their origin. These masses have obviously been deposited during the more recent periods of the earth's physical history, and no considerable changes of surface have occurred since. They are superficial, naked, often lying upon bare rock, or upon sand or gravel, and often they are in such delicate positions as to equilibrium, that earthquake or deluge would have easily displaced them. Perhaps Prof. Playfair, of Edinburgh, first pointed out the importance of glaciers as a moving power; he understood their motion, and was much impressed by the magnitude and variety of the ruins which they transport, even where there is little declivity, and over ground quite uneven. In a journey in 1816, he observed the masses on the Jura, and he distinctly attributed them to glaciers which once crossed the lake of Geneva and the plain of Switzerland, and he denies that a current of water, however powerful, could have carried huge *blocs* up steep declivities. That there has been great variation in the extent of the glaciers is proved by the fact, that between the eleventh and the fifteenth centuries, passes in the mountains which are now rarely traversed at all, were often threaded by the inhabitants on foot and on horseback.

It is well known that Venetz, De Charpentier, and especially Agassiz, have given great extent to the glacial theory, and Agassiz "has attempted to extend it with some variations to every part of the temperate zone, and to explain the distribution of the Scandinavian blocks and those of Great Britain by a similar action."

Whatever may be thought of this extension, Prof. Forbes considers the admission of glaciers one hundred miles long or more, as a less extravagant hypothesis than might be imagined. The absence of such a degree of cold in the existing climate, and the want of a sufficient declivity, are obvious objections to this view. But "the quantity is often so great as almost entirely to conceal the mass of the ice under the prodigious load, which, during a long descent, is accumulated upon them." In some cases they fill up entire valleys. Masses may now be seen on the glaciers, nearly or quite as large as those in the valleys. The author estimated the magnitude of a block which he saw in the valleys, as being nearly one hundred feet long and forty or fifty feet high, and a fragment of slate in the valley of Saas pushed along by the glacier of Swartzburgh, is estimated to contain two hundred and forty four thousand cubic feet, which would require an average diameter of nearly sixty two feet. Glaciers chafe and polish the rocks over which they are pushed or dragged; they wear down the solid granite, or slate, or limestone. "They rub and wear and polish the rocks with which they are in contact. Struggling to dilate, they follow all the sinuosities and mould themselves into all the hollows and excavations they can reach, polishing even overhanging surfaces."

Glaciers carry along with them masses of pulverized gravel and slime, which, pressed by the enormous superincumbent weight of ice, do effectually grind and smooth the surface of the rocky bed; the turbid water of the glaciers, charged with the fine material that has been ground between the rock and the ice, exhibits the same appearance from age to age.

The harder fragments are set in the ice as the emery is set in the wheel of the lapidary, and "the gravel sand and impalpable mud are the emery of the glacier." The glaciers are always wearing, scratching, marking, and polishing the sides of the rocks against which they are pressed in their downward progress, and these lateral grooves are often visible at great elevations, even far above any existing glaciers. This is remarkably exhibited in the defiles and mountain cliffs between the primary Alps and the secondary Jura mountains.

These ranges are parallel with the great valley of Switzerland which lies between them and is dotted with lakes; the direction of the valley is N. E. and S. W.: it is about thirty English miles wide, but the distance from the highest part of the Alps to the highest part of the Jura, is not less than eighty miles. "Near to the great gap in the main chain formed by the valley of the Rhone we have the lake of Neufchatel, with mountains of secondary limestone, in some parts of the age of the English oolite, and rising to about three thousand feet above the valley." Upon the slope of this range, and at a considerable elevation above it and facing the valley of the Rhone, there are extensive deposits of angular *blocs* of granite, of the kind found on the eastern side of Mont Blanc, the nearest spot where these rocks occur *in situ*, and no rock in the least similar is found any where in the Jura, or nearer than that part of the Alps already named, "and which may be sixty to seventy miles distant as the crow flies." "A great belt of these *blocs* occupies a line, extending for miles, at an average height of eight hundred feet above the level of the lake of Neufchatel, and above and below that line they diminish in numbers, although not entirely wanting." Multitudes of them have been broken up and removed for architectural purposes, or merely to clear the land, and many are concealed among the trees of the mountain forests, "but wherever seen, they fill the mind with astonishment, when it is recollected that as a matter of certainty, these vast rocks, larger than no mean cottages, have been removed from the distant peaks of the Alps, visible in dim perspective amidst the eternal snows, at the very instant when we stand on their debris. The celebrated bowlder called Pierre a Bot, or toadstone, in this vicinity, about two miles west of Neufchatel, is fifty feet long, twenty wide, and forty high, and contains forty thousand French cubic feet. It forms a stupendous monument of power. It is impossible to look at it without emotion, after surveying the distance which separates it from its birth-place." There are besides in the neighborhood, hundreds and thousands of truncated *blocs*, some small and rounded, but a vast number exceeding a cubic yard in contents and perfectly angular, or at least with only their corners and edges slightly worn, but without any appearance whatever of considerable attrition, or any violence having been used in their transport. Indeed, such violence would be quite inconsistent with their appearance and present position." The *blocs* are distributed in an orderly manner, those from the same origin being generally grouped together.

The author rejects the idea that these masses were driven along by rushing water, that they slid down an inclined plane, or even that they were transported upon floating rafts of ice, and favors or perhaps espouses the theory of their transportation by glaciers that once occupied the whole intervening space between the high Alps and the Jura, filling of course the valley of Switzerland, and crossing its numerous lakes; the recession being gradual through a long series of years, and depositing the moraines or lines of rocks as they are now found on the Jura, and as they are at this moment in the course of being deposited towards the heads of the valleys. Between the Alps and the lake of Geneva, into which the Rhone empties, this river passes through a narrow and deep gorge in the mountains at St. Maurice—a grand scene, which is familiar to all Swiss travellers.

"If the glacier which then filled all the upper and tributary valleys, whose waters now form the current of the Rhone, passed through this place, it must have been violently accumulated in this ravine, and pressed with excessive force upon the bottom and sides of the valley. The marks of glacier wear and polish are here extremely visible, especially on the rocks which occupy the bottom between St. Maurice and Bex; and they extend to a very great height on the eastern side of the valley, exactly opposite to the village of Bex, where M. de Charpentier pointed out to me the most exquisitely polished surfaces of rocks, quite as smooth as a school-boy's slate, and displaying an artificial section of all the interior veins. After passing the defile of St. Maurice, the glacier spreads itself over the enlarged basin immediately beyond, partly formed by the tributary Val d'Illiers. The whole face of that valley fronts the tide of ice which then flowed through the rocky defile, (on the theory we are discussing,) and which bore upon it with its lateral moraine. The result is not less surprising than what we have described on the Jura."

The rock here too is limestone, and not more than a quarter of the distance from native granite, but the magnitude of the moraine is proportionally greater. The "blocs of Monthey," as they are called from the village immediately below them, must be seen to be appreciated. "I wandered amongst them (says the author) a whole forenoon, and though I had previously heard much of their magnitude, I had formed no idea of what I then saw. We have here again a belt or band of *blocs*, poised as it were on a mountain side, it may be five hundred feet above the alluvial flat through which the Rhone winds below. This belt has no great vertical height, but extends for miles—yes, for miles along the mountain side, composed of *blocs* of granite thirty to forty, fifty and sixty feet in the side—not a few, but by hundreds, fantastically balanced on the angles of one another, their gray weather-beaten tops standing out in prominent relief from the verdant slopes of the secondary formation on which they rest."

"For three or four miles there is a path preserving very nearly the same level, leading amidst the gnarled stems of ancient chestnut trees, which struggle round and among the piles of *blocs*, which leave them barely time to grow. The trees, opening here and there, display the rich cultivated valley of the Rhone beneath, whilst the snow-clad Alps, whose fragments are beneath our feet, close the farther distance. The *blocs* are piled one on another, the greater on the smaller, leaving deep recesses between, in which the flocks or their shepherds seek shelter from the snow-storm, and seem not hurled by a natural catastrophe, but as if balanced in sport by giant hands. For how came they thus to alight on the steep and there remain? What force transported them, and when transported, thus lodged them high and dry, five hundred feet at least above the level of the plain? We reply a glacier *might* do this. What other inanimate agent could do it we know not."

Our author clambered to the top of the precipices, fifteen hundred feet above the valley of the Rhone, which form the mural angle between the Sallenche River and the Rhone. Now, these vertical precipices on which repose erratic *blocs*, are "scored by horizontal stripes, or grooves, or fluting, evidently the result of superficial wear. But what could have worn it in this position? What could have been moved with a steady pressure, as a carpenter presses his cornice plane to the wood, or as a potter moulds with a stick his clay, pressed laterally too with a perpendicular face of fifteen hundred feet beneath? Nothing that I am acquainted with save a glacier, which, at this day, presses, and moulds, and scores the rocky flanks of its bed, extending to a depth often certainly of hundreds of feet beneath. A torrent however impetuous, a river however gigantic, a flood however terrific, could never do this." Among modern ruins of the moraines we may cite that of 1820* at the Humeau des Bois, where the erratic rocks "lie scattered almost at the doors of the houses, and have raised a formidable bulwark at less than a pistol shot distance, where cultivation and all verdure suddenly cease, and a wilderness of stones of all shapes and sizes commences, reaching as far as the present ice."

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* The period of the greatest extension of this glacier.

We have already made more extensive citations than we intended from this very interesting work, and shall conclude with a few miscellaneous selections.

The crevasses of the *Mer de Glace* were observed to extend two thousand feet, or sometimes half across the glacier, and to be often fifteen or twenty feet wide, with walls perfectly vertical; they are evidently in some cases formed by the straining of the ice over obstacles; they begin with a sudden noise, and at first are mere cracks into which the blade of a knife would scarcely enter. They are often obliterated or closed up, especially in winter, and are in a good measure renewed every year, and chiefly in summer, when they frequently undergo a prodigious enlargement. On the Montanvert there is a moraine two hundred and forty feet above the present glacier, thus proving its former elevation. Professor Forbes found the remains of what was believed to be Saussure's ladder, which he left in the glacier in 1788; and comparing dates and distances, it appears to have travelled 16,500 feet in forty-four years, at the rate of 375 feet per annum for the motion of this part of the glacier; but observations made in other places gave an approximation to five hundred feet in a year. It seems not unreasonable to conclude that the rate of descent may vary in different glaciers. The apparent elevation of rocks by the sinking of the ice around them, has been mentioned. In connection with the medial moraine of the Talafre, there was a very remarkable stone of this description. It was twenty-three feet long by seventeen feet, and three and a half thick. On the 6th of June, 1842, it stood on an elegant pedestal of ice very delicately poised, and upon this stone the traveller erected his theodolite to make his observations. On the 13th of August, the supporting pedestal was thirteen feet high, and soon after the stone slipped from its position, and in September it was beginning to rise again upon a new icy column, or in other words, the glacier was wasting all around it, and the stone protected the portion on which it reposed, so that it relatively rose.

A rock that had been smoothly rounded by attrition, was called by Saussure *Roche montonnée.*

Near Pont Pelissier such rocks are accompanied by bowlders, "one of which of immense size and angular shape seems poised on the very summit of one of these beehive-like summits;—rocks so situated are called by De Charpentier *blocs perchées.*

"Near St. Gervais are numerous and extensive moraines, although the nearest modern glacier is some hours' walk distant. The rocks in place are slaty limestone, but *blocs* of granite abound, sometimes accumulated in ridge-like mounds along the face of the slopes exactly like moraines—in other cases insulated and of great size, thirty or forty feet in length; and they are well characterized protogine or granite of the chain of Mont Blanc. The Pavillon de Bellevue on the Col de Bellevue, is nearly seven thousand feet above the sea, and yet erratic *blocs* are strewed all around upon it. These erratic *blocs* mix insensibly with the modern moraine of the glacier of Bionassy beneath, so that it is impossible to say where the erratic phenomenon ends and where the glacial phenomenon begins."

A very striking argument in favor of the glacial theory of erratics is thus presented on the spot, and these very *blocs* of protogine granite continue for many miles down the country without any intermission. The Lac de Combal is bounded by moraine; it pushes along several miles in length, nearly a mile in breadth, and several hundred feet deep. "The old moraines are still fortified with slits for musquetry, probably erected by the Piedmontese troops in 1794. It is strange to see this application of the artificial looking mounds which the glacier has raised, and which bear no slight resemblance to a series of gigantic outworks of an extensive fortification." The moraines are here formed in the shape of semilunar curves or crescents, of which there are four, with their convexity up the valley; and the outermost of these was occupied as a fortification. "The icy torrent as it spread out in the Allée Blanche, appeared to me to be three and a half miles long, and one and a half wide. After struggling for a long time among fissures and moraines, I at length mounted a heap of *blocs* higher than the rest, and surveyed at leisure the wonderful scene of desolation, which might compare with that of chaos, around me. The fissures were so numerous, large and irregular, as to leave only a series of unformed ridges, like the heaving of a sluggish mass, struggling with intestine commotion, and tossing about over its surface, as if in sport, the stupendous blocks of granite which half choke its crevasses, and to which the traveller is often glad to cling, when the glacier itself yields him no farther passage. It is there that he surveys with astonishment the strange law of the ice-world, that stones always falling seem never to be absorbed—that, like the fable of Sisyphus reversed, the lumbering mass, ever falling, never arrives at the bottom, but seems urged by an unseen force still to ride on the highest pinnacle of the rugged surface. But let the pedestrian beware how he trusts to these huge masses, or considers them as stable. Yonder huge rock, which seems 'fixed as stable Snowdon,' and which interrupts his path along a narrow ridge of ice, having a gulf on either hand, is so nicely poised, 'obsequious to the gentlest touch,' that the fall of a pebble, or the pressure of a passing foot, will shove it into one or the other abyss, and the chances are, may carry him along with it. Let him beware too, how he treads on that gravelly bank, which seems to offer a rough and sure footing, for underneath there is sure to be the most pellucid ice; and a light footstep there, which must not disturb a rocking stone, is pregnant with danger. All is on the eve of motion. Let him sit awhile, as I did, on the moraine of Miage, and watch the silent energy of the ice and sun. No animal ever passes, but yet the silence of death is not there; the ice is cracking and straining onward—the gravel slides over the bed to which it was frozen during the night, but now lubricated by the effect of the sunshine. The fine sand detached loosens the gravel which it supported—the gravel the little fragments, and the little fragments the great; till, after some preliminary noises, the thunder of clashing rocks is heard, which settle into the bottom of some crevasse, and all is again still."

Among the many dangers encountered in travelling through these regions, not the least arises from the fall of stones. "A stone, even if seen beforehand, may fall in a direction from which the traveller, engaged amidst the perils of crevasses, or on the precarious footing of a narrow ledge of rock, cannot possibly withdraw in time to avoid it, and seldom do they come alone. Like an avalanche, they gain others during their descent. Urged with the velocity acquired in half rolling, half bounding down a precipitous slope of a thousand feet high, they strike fire by collision with their neighbors—are split perhaps into a thousand shivers, and detach by the blow a still greater mass; which once discharged, thunders with an explosive roar upon the glacier beneath, accompanied by clouds of dust or smoke produced in the collision. I have sometimes been exposed to these dry avalanches; they are among the most terrible of the ammunition with which the genius of these mountain solitudes repels the approach of curious man. Their course is marked on the rocks, and they are most studiously avoided by every prudent guide."

The story of the debacle of the Val de Bagnes in 1818, is adverted to, p. 262, and Prof. Forbes became acquainted with the very ingenious engineer, M. Venetz, who so ably endeavored to arrest the catastrophe of Martigny. The event has been often adverted to in geological travels. A mountain torrent formed by the snow floods, augmenting the river Drause, which was dammed up by the ice, formed a lake one mile and a half long, seven hundred feet wide and at one part two hundred feet deep. This dam M. Venetz sluiced by a canal six hundred feet long, with the labor of thirty four days, but the ice gave way and "a deluge of five hundred millions of cubic feet of water was let loose, in the space of half an hour, to sweep through a tortuous valley full of dedefiles, literally with the besom of destruction. A flood five times greater than that of the Rhine at Basle, filled the bed of a mountain torrent. In the short space of its course from Getroz to Chable, the fall is 2,800 feet; its acquired velocity was therefore enormous at the commencement of its course, thirty three feet in a second, and therefore its power to overthrow buildings and to carry with it trees, haystacks, barns and gravel, cannot surprise us. Enormous masses of rock were moved, but there is no evidence that granite masses were brought down from the higher valleys by the torrent." A similar catastrophe happened in this valley twice in the 16th century, and to prevent its occurrence, men are employed during many weeks in summer, by turning upon the ice streamlets of water, which saw it in two; but a permanent tunnel through the mountain, appears to promise the only certain protection.

An electrical phenomenon occurred at an elevation of more than 9000 feet above the sea, which although not uncommon, may be worth mentioning, (p. 323.) The ground was covered with half melted snow and some hail was falling, when a curious sound was heard to proceed from the Alpine pole with which the traveller was walking. On holding his hand above his head, the fingers gave a whizzing sound, and it became apparent that they were so near a thunder cloud as to be highly electrified by it. All the angular stones around were perceived to be hissing like points near a powerful electrical machine. One of the guides was carrying an umbrella against the hail storm, and its gay brass point was likely to become the *paratonnéere* of the party; he was therefore requested to lower the point, and the word was hardly uttered before a clap of thunder unaccompanied by lightning justified the precaution. They found some *huts of miners* 10,800 feet above the sea, the highest temporary habitation in Europe.

In closing our extracts from this great work, so rich in valuable and interesting materials, we cannot deny ourselves the pleasure of giving an abridged account of a sketch by which Prof. Forbes illustrates the danger of wandering *alone* amid these icy regions. On the 17th of September, 1842, having with his guide ascended a lonely promontory whose "vast sheets of granite nearly vertical, occur up to a great height, with a sort of shelf above the glacier level, covered with detached masses of granite;" he sent Auguste in search of water. Becoming uneasy at the long absence of the man, Prof. Forbes proceeded in search of him and met him with two lads of Chamouni, leading between them an American traveller, whom with much difficulty they had rescued from a ledge of rocks on which he had passed the whole night. The adventurer had rambled alone on the morning of the preceding day over these solitary precipices, and toward afternoon having slipped over a rock where his fall was checked by some bushes, he found himself on a ledge of granite, shut in on every side. Here he had passed the whole night, and having in the morning by his cries succeeded in attracting the attention of some young men from Chamouni, who were passing far below, with much danger by a circuitous path they were able to gain a position above him. Their efforts would have been in vain had not the guide of Prof. F. providentially encountered them while on his search for water. With great strength and courage Balmat succeeded in drawing the man up by the arm from "a spot where a chamois could not have escaped alive." Auguste told Prof. F. that while he bore the entire weight of the man on the slippery ledge of rock to which he himself clung, he felt his foot give way and for a moment thought himself lost. After having refreshed the exhausted traveller with food and wine, he was conducted back to Chamouni, while Prof. Forbes with his guide, went to view the place from which he was rescued. It was a ledge in most places about a foot wide and several feet long, with grass and juniper growing upon it. It thinned off upon the cliff entirely in one direction, and on the other where widest, terminated abruptly against an overhanging rock ten feet high, which no one unassisted could have ascended. "The direction of his fall was attested by the shreds of his blouse hanging to the bushes which he had grazed in his descent; but for which evidence it would have seemed impossible that any falling object could have so attained the shelf on which he was miraculously lodged. Immediately below the spot from which he fell, the shelf thinned off so completely that it was plain he must have fallen obliquely across the precipice so to reach it. "The ledge was twenty feet below the top of the smooth granitic precipice, to which a cat could not have clung, and below, the same polished surface went sheer down without a break for at least two hundred feet where it sinks into the glacier." "A more astonishing escape it is scarce possible to conceive. It is probable that had not the young men crossed the glacier at this fortunate moment, my guide and I would have passed the rock fifty yards above him, (it was in the direction in which we were going,) without either party having the remotest idea of the other's presence."

It is painful to conclude this story with the following note of Prof. Forbes, p. 83. "I regretted to learn afterwards, that he had not shown himself generously sensible of the great effort used in his preservation."

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## Art. XXIII.—*Bibliographical Notices.*

1. *Reliquiæ Baldwinianæ: selections from the correspondence of the late Wm. Baldwin, M. D., Surgeon in the U. S. Navy, with occasional notes, and a short biographical memoir;* compiled by Wm. Darlington, M. D. Philadelphia, 1843. pp. 346, 12mo.—In editing the scientific remains of the amiable Baldwin, Dr. Darlington has fulfilled, and well fulfilled, a duty peculiarly incumbent upon him; for he is certainly the appropriate literary executor of his lamented friend. Born in the same county, and nearly of the same age, the subject of this

volume and its editor, while fellow-students at the medical school of Philadelphia, were drawn together by kindred tastes, and early became cultivators of the science in which they have both distinguished themselves;—the one as the historian of the plants of his native district; while the other gathered his early laurels in the almost untrodden savannahs of Georgia and Florida, and soon after, when just entering upon a field of still richer promise, found an untimely grave on the banks of the Missouri. In his latest communications, Dr. Baldwin consigned his botanical papers to the charge of the late Mr. Zaccheus Collins and Dr. Darlington. They were accordingly placed in the hands of Mr. Collins, who purchased of the heirs at law the collection of dried plants, intending, it seems, to present it to the Academy of Natural Sciences of Philadelphia. It is much to be regretted that Dr. Baldwin was prevented by professional engagements and infirm health from completing his notes upon his rich collections in the Southern States, according to his original intention, before joining the western exploring expedition commanded by Major Long. For these manuscripts, as we know from personal examination, contain a very skillful revision of some difficult genera, especially in the Cyperaceæ, accurate diagnoses of new or ill-understood species, and original observations much in advance of the general state of botanical knowledge with us in those days; and their timely publication would not only have largely contributed to the advancement of his favorite science, but have formed the most enduring record of his labors and attainments, as well as the most appropriate monument to his own memory. Although bright hopes and high promise were thus frustrated by death, yet Dr. Baldwin's hard-earned scientific reputation might still have been in some good degree secured, had these manuscripts fallen into judicious editorial hands at an earlier period; when their scientific importance would have justified, or rather have required their publication, even in the imperfect state in which the author left them. But Dr. Darlington naturally felt a delicacy in interfering with the first-named executor, Mr. Collins, who also possessed the herbarium; but whose excessive caution, as it deterred him from publishing any of his own observations, (or even from giving, so far as is known, a decided opinion upon a botanical question during his whole life, except in a single instance,) would alone effectually have prevented him from taking such responsibility with the writings of another person. Indeed, the manuscripts were supposed to be lost, and they only came to Dr. Darlington's knowledge very recently, after he had arranged the principal contents of this volume for the press, and when they had ceased to possess other than historical interest. For the steady progress of the science during the last twenty years has nearly annihilated their strictly scientific value, the new plants having mostly been published already by contemporary or succeeding botanists; one of whom, we are sorry to say, has not always paid the deference which courtesy and common justice require to the names under which the discoverer distributed them. Under these circumstances, and remembering that this lamented botanist seems to have deprecated the indiscriminate publication of his unfinished papers, we are convinced that the judicious editor could not do otherwise than disregard, as he has done, these once invaluable materials, and leave the reader to gather a general idea of Dr. Baldwin's indefatigable labors and rare promise, from the perusal of his familiar letters. About half the volume is accordingly occupied with the correspondence between Baldwin and Muhlenberg, which, commencing in the year 1811, and actively carried on until the death of that estimable botanist, in 1815, abounds with interesting matter, and contains many casual notices of contemporary botanists, which we would not willingly lose. A few letters to the late Mr. Lambert, Vice President of the Linnæan Society, are followed by a more extended series addressed to Dr. Darlington himself. These form, in our estimation, the most characteristic part of the volume; as they have the vivacity, simplicity, and freshness, and consequently the lively interest, which belong only to letters addressed to a familiar friend, without the remotest idea of their being seen by a third person. The series, too, embraces the later and most interesting portion of the writer's life; the last year of his residence in Florida, (1817); his cruise in the U. S. frigate Congress, with the government commissioners sent to Buenos Ayres, Montevideo, &c., for the purpose of ascertaining the condition and prospects of the South American colonies, then struggling to establish their independence; his return to Wilmington, Delaware, where his time was chiefly occupied in preparing for publication, at Dr. Darlington's request, a set of spirited articles, entitled "*Notices of East Florida and the sea coast of the State of Georgia, in a series of letters to a friend in Pennsylvania*," filled with valuable observations upon the condition, resources, productions, and botany of that country, but which unfortunately were left half finished when he was called to join the expedition under Major Long: still the fragment which the editor has introduced at the close of the volume, will be read with great interest. From the latter part of the correspondence with Dr. Darlington, we gather many data respecting the origin and early progress of Long's expedition, which appears to have been attended with the usual amount of bad management, vexation, and disappointment. One item of the instructions from government might perhaps have been advantageously copied on a more recent occasion, viz. that in which the commander and journalist are instructed "*not to interfere with the records to be kept by the naturalists attached to the expedition.*" But Dr. Baldwin's health was totally unequal to the undertaking in which he embarked with characteristic enthusiasm. The victim of pulmonary disease, "his strength failed him ere the expedition was fairly under way; and he died at Franklin, on the banks of the Missouri, on the first day of September, 1819, in the forty-first year of his age. His gentle spirit forsook its frail tenement in a region far remote from his anxious family, and the wild flowers of the west, for more than twenty years, have been blooming on his lonely grave; but the recollection of his virtues continues to be fondly cherished by every surviving friend; and his ardor in the pursuit of his favorite science will render his memory forever dear to the true lovers of American botany."

We had intended to extract a large part of the editor's neat and concise biographical sketch, and especially to make some selections from the correspondence; but we fear that we have already exceeded the limits of a bibliographical notice. Were we allowed a single extract, our choice would fall upon pages 215–216, relating to the Indians of Florida and Georgia, and the treatment they have received. In his love and sympathy for these children of the forest, Dr. Baldwin forcibly reminds us of his predecessor, William Bartram, (to whom, by the way, he paid a visit in 1817, of which a pleasing notice is given on p. 238.) The latter enjoyed the hospitality of these tribes in their palmy days. The indignant epistle of Baldwin describes and denounces a course of policy which he observed in full operation, and which, in less than thirty years, has wrought out the predicted result. But we must abruptly conclude our desultory remarks with the expression of our thanks to Dr. Darlington, for this worthy tribute to the memory of a most zealous botanist, and very important contribution to the history of the *amiable science* in this country. A. Gr.

2. *Cours élémentaire de Botanique;* par M. Adrien de Jussieu, Professeur au Muséum d'Histoire Naturelle, etc. etc. Paris. Part I. pp. 226, 12mo.—This treatise forms a part of an elementary course of natural history, for the use of the colleges and other schools in France, prepared in conformity with a *programme* of the Council of Public Instruction on the 14th of September, 1840, and which consists of three small volumes; that on Zoology by Milne Edwards; that on Mineralogy and Geology by Beudant; while the botanical portion was confided to the hands of the son of the immortal author of the *Genera Plantarum*, and his successor in the professorship at the Royal Museum of Natural History. The first part of the volume only has yet appeared, and is devoted to the *Organs and functions of vegetation, or nutrition.* It includes, however, a very interesting chapter upon *Inflorescence*, a subject which would seem rather to belong to the system of reproduction, but which is very naturally introduced in connection with the chapter on

ramification. The author does not hesitate to discuss, in this elementary treatise, most of the questions which are now exciting the attention of physiologists; such as the development of the simple tissues, the nature of the endogenous structure, the doctrine of phyllotaxis, cyclosis, intercellular rotation, etc. We await with much interest the appearance of the second part of this excellent introduction to botany.

A. Gr.

3. *Grundzuge der Botanik, entworfen* von Stephan Endlicher und Franz Unger. Vienna, 1843. pp. 494, 8vo.—In the production of this admirable text-book, one of the most accomplished systematic botanists of the age has been joined by his friend, a distinguished physiologist. The work is divided into two parts; the first treating of the nature of plants as individuals; the second, of plants viewed as composing a systematic unity, a vegetable kingdom. The first part comprises, 1st, Histology, or an account of the elementary organs of plants; 2d, Organology, corresponding to organography; and 3d, the Physiology of plants; and is illustrated by 450 figures on wood. The most interesting portion, in the present state of vegetable morphology, is the chapter on the *gynæcium*, in which Endlicher, who, it is well known, early adopted the *axile theory of placentation*, has here applied it in detail to the various forms and modifications of the ovary. The chief advantage of this theory is, that it harmonizes in the simplest manner the laws of placentation with the general law which regulates the production of buds. It appears to be the prevalent theory on the continent, and might have been generally adopted, had it not met with so formidable an opponent in Mr. Brown, the person best qualified to decide such questions, and who has brought against it the most direct and apparently unanswerable arguments. In the second part of the work, we have, firstly, a brief exposition of the fundamental principles of Systematic botany. This is followed by a chapter on Geographical botany, which treats of the propagation and distribution of plants over the earth's surface, and of the causes which control this distribution; such as the temperature of the air and of the earth, the humidity of the air, the constitution of the soil, &c.; and finally, we have an enumeration of the twenty-five districts of vegetation, and their characteristic forms, as proposed by Schouw. Lastly, an interesting chapter is devoted to the history of the vegetable kingdom, or the mutations which plants have undergone in time, whether in remote geological periods, or since the creation of man, from causes still in action. A. Gr.

4. *Lehrbuch der Botanik;* von Dr. G. W. Bischoff, Prof. Bot. Univ. Heidelberg. Stuttgart, 6 vols. 8vo, with 16 plates in 4to, 1834–1840. —This elaborate manual forms a part of the *Naturgeschichte der drei*

*Reiche;* a series of natural history text-books, prepared by Professors Bischoff, Blum, Bronn, Leonhard, Leukart, and Voight. The first three volumes of Prof. Bischoff's work are devoted to *General botany;* under which he treats, 1st, of the external conformation of plants, or Organography; 2d, of their internal, or anatomical structure, Phytotomy; 3d, of their chemical composition, or vegetable chemistry; 4th, of the phenomena of vegetable life, under normal conditions, or vegetable Physiology; 5th, of these phenomena in abnormal conditions, or vegetable Pathology, under which head is considered not only the diseases, but also the monstrosities of plants; 6th, of their distribution over the earth, or Geographical botany; 7th, of the origin of plants, and of the changes which the vegetable kingdom has undergone in the lapse of time, i. e. the history of plants; 8th, of the mutual relations or affinities of plants, and the principles of their scientific arrangement, or Systematic botany and Phytography; and 9th, the history of botany from Theophrastus down to A. D. 1838. To each division is appended a very complete and useful list of the works upon that department of the science. The fourth and fifth volumes, entitled *Special Botany*, are occupied with a very full exposition of the natural system, as disposed by Bartling; in which the characters of the orders and other leading divisions are given in detail, and the most important genera and species popularly described. The last volume, or appendix, contains the Glossology of the science in the form of a dictionary; the Latin terms in the first part being explained in German, while in the second the German technical terms are defined by their Latin synonyms. A. Gr.

5. *Grundriss der Botanik, zum Gebrauche bei seinen Vorlesungen;* von Georg Fresenius, M. D., &c. Ed. 2. Frankfort, 1843. pp. 90, 8vo.—This brief sketch of the science comprises the "ground-work" of Dr. Fresenius' botanical lectures, and is chiefly designed as a text-book for his class. It treats, first, of the chemical elements of plants, then of their organography in the ordinary course, and finally, of their systematic arrangement; giving under the latter head a conspectus of Jussieu's, De Candolle's, and Endlicher's several modes of distributing the natural orders. A. Gr.

6. *Buek's Index generalis et specialis ad A. P. De Candolle Prodromum Syst. Nat. Reg. Vegetabilis, &c.*—The second part of this useful index of the genera and species in De Candolle's Prodromus, comprising the Compositæ, was published in 1840, and was duly announced in this Journal. But the first part, forming an index to the first four volumes of the Prodromus, appeared much later, viz. at the close of the year 1842, (forming 423 pages, 8vo.,) so that botanists are now furnished

with a complete index to that invaluable work, down to the first part of the 7th volume. We may here state, that the 8th volume of De Candolle's Prodromus was probably published at Paris in December last, and will doubtless reach us in season for a notice in the ensuing number of this Journal. A. Gr.

7. *Ledebour's Flora Rossica.*—The first part of this work, published in 1841, was announced in a former number of the Journal, (Vol. xliii, p. 188.) The second, published in 1842, comprises the natural orders from *Violaceæ* to *Geraniaceæ*, following the series of De Candolle's Prodromus. Much the largest family of this portion is the *Caryophyllaceæ*, especially the *Alsineæ*, which are here elaborated by their assiduous monographer, Dr. Fenzl, of Vienna, in such a manner as satisfactorily to clear up the doubts and obscurities that rested on many of our northern species. We hope soon to be able to announce the publication of Dr. Fenzl's complete revision of this family. The third part of the Flora Rossica, which completes the first volume, (of 786 pages,) was published in 1843, and has just reached us. It continues the series from *Balsamineæ* to the end of *Leguminosæ;* the latter being, of course, much the largest order of the Exogenæ Polypetalæ. The Russians are actively engaged in exploring their remote Asiatic provinces, but their American possessions do not appear to have been visited of late years by any botanist. Consequently, this work has thus far thrown very little additional light upon that portion of the flora of our own continent.

A. Gr.

8. *A Manual of British Botany, containing the Flowering plants and Ferns, arranged according to natural orders;* by Charles C. Babington, M. A., F. L. S., etc. London, Van Voorst, 1843. pp. 400, 12mo.—This new compendium of British plants is formed on the model of Koch's excellent *Synopsis Floræ Germanicæ*, (which we are glad to learn is now passing to a second edition.) The author has been highly praised for his knowledge and acumen, even by those who are far from agreeing with him in many of his conclusions respecting the validity of particular species. Mr. Babington found it necessary to make a careful comparison of the British with the continental flora; "for it appeared that in very many cases the nomenclature employed in England was different from that used in other countries, that often plants considered as varieties here, were held to be distinct species abroad, that several of our species were looked upon only as varieties by them, and also that the mode of grouping into genera was frequently essentially different." This state of things the author conceives to be the result of the long-continued interruption of scientific intercourse between England and

the continent during the war with France, and the firm establishment of the Linnæan artificial system consequent upon the great popularity of Smith's Flora of Britain, &c. "At the conclusion of the war," says Mr. B., "we had become so wedded to the system of Linnæus, and it may even perhaps be allowable to add, so well satisfied with our own proficiency, that, with the honorable exception of Mr. Brown, there was at that time scarcely a botanist who took any interest in, or paid the least attention to the classification by natural orders, which had been adopted in France, and to the more minute and accurate examination of plants which was caused by the employment of that philosophical arrangement. * * * * The publication of so complete and valuable a Linnæan work as the *English Flora*, greatly contributed to the permanency of this feeling; and accordingly we find that, at a very recent period, working English botanists were unacquainted with any of the more modern continental floras, and indeed, even now, many of those works are only known by name to the great mass of the cultivators of British botany." The author has adopted Koch's plan of distinguishing the essential and diagnostic portions of the specific characters by italic type, which thus strike the eye at a glance. The author, or, perhaps we should say the printer, seems quite undecided whether to write specific names derived from persons with a small initial, as recommended in the report of the committee on nomenclature to the British Association; or with a capital initial, according to common (and proper) usage; for in this manual both modes are followed in about an equal number of cases. A. Gr.

9. *Kunze's Supplemente der Reidgräser* (*Carices*) *zur Schkuhr's Monographie*, &c. Part 3d, (Leipsic, 1843.) Plates 21—30.—The third part of Prof. Kunze's valuable continuation of Schkuhr's Carices contains good figures of the following North American species; viz. *C. rufina*, Drejer; *C. nardina*, Fries (=C. Hepburnii, *Boott. in Hook.*;) *C. subspathacea*, Hornem. (=C. bracteata, *Giesecke?* C. salina, var. *Wahl.* C. Hoppneri, *Boott.*;) *C. Wormskioldiana*, Hornem. (=C. Michauxii, *Schweinitz*;) *C. Careyana*, Dewey; *C. æstivalis*, M. A. Curtis; and *C. stylosa*, Meyer (=C. nigritella, *Drejer.*) We also learn that the well-marked *Carex stenolepis* of Torrey must needs bear the name of C. Frankii given by Kunth; as there is a prior *C. stenolepis* established by Lessing (*Reise durch Norwegen, etc.*) so long ago as the year 1831; although Kunth does not mention it in his Cyperographia, published six years later. As if to increase the confusion of synonymy, we find that the name of this species is changed to *C. Shortii* in Steudel's *Nomenclator Botanicus, ed.* 2, the anterior C. Shortii of Dewey being omitted.—It may be remarked that Dr. Knieskern has lately

rediscovered *C. Barrattii* in New Jersey, and that it proves to be identical with the European *C. flacca* of Schkuhr. We may also take this opportunity to state that *C. miser* of Mr. Buckley, described in this Journal, Vol. XLV, p. 173, is probably identical with the *C. juncea*, Willd., described from specimens cultivated in the Berlin Botanic Garden, the particular derivation of which cannot now be traced. A. GR.

10. *Botanische Zeitung.* (Berlin, A. Forstner. Subscr. 4$\frac{5}{6}$ Pruss. thalers per annum.)—This interesting botanical newspaper, which commenced in January, 1843, is most ably conducted by Prof. Mohl of Tübingen, the distinguished vegetable anatomist, and Prof. Von Schlechtendal, the well-known editor of the Linnæa. It is occupied with original articles upon vegetable anatomy, physiology, morphology, and systematic botany, and with brief but spirited reviews or critical notices of new publications, accounts of the proceedings of learned societies, and general botanical news.

As this weekly gazette embraces within its scope the matter formerly given in the *Litteratur-Bericht* of the *Linnæa*, the supplementary department of that journal is now discontinued, and, having completed the 16th volume, a new series is commenced, under the slightly modified title of *Linnæa, ein Journal für die Botanik, etc.; oder Beitrage zur Pflanzeukunde.* A. GR.

11. *Prof. Forbes's Bakerian Lecture.*—We have received from the respected author, and perused with much interest, the lecture of Prof. Forbes of Edinburgh, "On the Transparency of the Atmosphere, and the Law of Extension of the Solar Rays in passing through it." Efforts have been made from time to time by eminent meteorologists, to determine the proportion of the sun's heat absorbed in passing through the atmosphere, (a subject like that of atmospheric refraction, of great importance to the most refined astronomical inquiries,) and the resources of geometry have been combined with direct experiments, to ascertain the law of extinction of the solar rays in passing through successive strata of the atmosphere. But a more promising mode of establishing this law, and of ascertaining the actual amount of loss of solar heat from atmospheric absorption, is by simultaneous observations of the comparative intensities of solar heat at different altitudes. Sir John Herschel's actinometer supplied the instrument best adapted to such observations. Furnished with several of these instruments, accompanied by minute instructions from the illustrious inventor, Prof. Forbes resorted to the *Faulhorn*, a high and insulated mountain of Switzerland, extremely well adapted to the purpose. He had the good fortune to associate with himself Prof. Kämtz of Halle, likewise an accomplished

experimenter, and intent on meteorological inquiries. Furnished with every variety of instruments that could contribute to insure accuracy, the observers stationed themselves, the one at the summit of the mountain, and the other at its base, the difference in altitude being six thousand eight hundred and forty four feet, and therefore comprising nearly one fourth of the whole weight of the atmosphere. Their observations were prosecuted for a number of days during the month of September, under favorable circumstances, and the following *conclusions*, among others, were fully established:

That, on the hypothesis of uniform opacity, a standard atmosphere of 29·922 inches, having a mean dampness or ratio to saturation represented by ·56 nearly, would transmit 68½ per cent., or stop 31½ per cent. of the incident heating rays;

That the absorption of the solar rays by the strata of air to which we have immediate access, is considerable in amount, even for moderate thicknesses;

That the tendency to absorption through increasing thicknesses of air, is a diminishing one; and that the absorption almost certainly reaches a limit beyond which no further loss will take place by an increased thickness of similar atmospheric ingredients; and that the physical cause of this law of absorption appears to be the non-homogeneity of the incident rays of heat.

12. *Memoirs of the Chemical Society of London for* 1841, '42, *and* '43. Vol. I. R. & J. E. Taylor, London, 1843. pp. 258, 8vo. With the *Proceedings of the Society* for the same period. pp. 64, 8vo.

This valuable volume is the first fruits of the Chemical Society established in London in 1841. It contains forty two articles from twenty nine different authors, among whom are many of the most eminent chemists in England, and several names of high renown on the continent; of the former we may mention Drs. Ure, Graham, Johnston, Gregory, Playfair, &c. &c., and from the continent, Liebig, Bunsen, Stenhouse, Will, &c. &c.

Dr. Playfair's article on the milk of the cow, is a very interesting one, and valuable in a practical point of view, as indicating the best modes of feeding cows, and showing the changes in composition of the milk of a cow according to its exercise and food. Dr. Gregory gives a new method for obtaining pure silver from the chloride, by treating the latter, *while still moist*, with a strong solution of caustic potash, (sp. gr.=1·25,) enough of which is added to cover the chloride half an inch in depth, and then boiled; the chloride is thus all speedily converted into brown oxide of silver, which is washed with hot water to remove chloride of potassium, and is then either kept as oxide of silver or fused with a little carbonate of potash. Metallic silver, perfectly pure, is thus obtained with great ease and rapidity. The oxide of silver thus prepared we have used to dissolve in cyanide of potassium, for the purposes of the electro-metallurgist, with entire success.

Prof. Liebig has a very important paper on the preparation and uses of *cyanide of potassium*, a salt now of great value from its employment in gilding and silvering in the moist way, and recommends the following process. The yellow prussiate of potash is dried (until it falls to a white powder) on a hot iron plate, and then mixed with dried carbonate of potash in the proportion of 6 oz. of the latter substance to 16 of the former, and the mixture thrown at once into a Hessian crucible previously heated to redness, and kept at that temperature until the mixture is completely fused with lively effervescence. It is stirred with a glass rod, and when it has a clear amber color is taken from the fire; the brown flocks of matter (which are *metallic iron*) seen floating about in the liquid mass settle, and the clear fluid is poured on a marble slab, broken up, and it is fit for use. The reaction which takes place in this process gives us a portion of cyanate mixed with the cyanide, which interferes with no one of its uses. Liebig remarks that it is difficult to conceive with what extreme facility the cyanide of potassium deprives certain metallic oxides and sulphurets of their oxygen and sulphur, for of all known substances, it approaches nearest in that respect to pure potassium. He then describes the use of this salt as an agent in quantitative analysis, where it renders easy, many before difficult processes.

13. *The Encyclopædia of Chemistry, Theoretical and Practical, presenting a complete and extended view of the present state of Chemical Science;* by James C. Booth and Martin H. Boye. Philadelphia; Carey & Hart. 8vo, published in numbers, with plates and wood cuts. Nos. I and II.—This work is understood to be founded mainly on the celebrated Chemical Dictionary of Liebig and Wöhler, while it contains all that is most valuable in Ure and other English writers. The well known accuracy and knowledge of its conductors, is a sufficient guarantee for the value of the work.

It abounds in information useful to the manufacturer and artisan, and yet contains much to command the attention of the chemical student. We have read with much satisfaction the article on Affinity. Under Acids is a full table of organic and inorganic acids, with their sources, formulæ and authority. The tables under Alcohol are more full and varied than can be found elsewhere in our language, and the entire article under that head is most excellent, while the article on *Agriculture* embodies in a condensed form a great amount of valuable matter, embracing the new views on that subject. The several mineral species are given under their alphabetical heads, with their most important characters and analyses.

When finished, this work will be a most complete and valuable storehouse, well arranged for reference, into which one cannot look without finding something suited to his purpose. This edition is published in numbers, twenty-four of which will complete the volume. Each number contains about sixty-four pages of close type, at the remarkably small price of twenty-five cents each.

14. *Mr. Alger's edition of Allan's Phillips' Mineralogy.*—Mr. Alger has been for some time engaged in preparing for the press a new edition of Mr. Phillips' popular treatise on mineralogy, taken from the last English edition by Allan. Much new matter and about fifty new figures have been added to the "Introduction" on Crystallography, besides many new original figures of species and new measurements of angles. The new and modern analyses of old species have been in many instances substituted for those of Vauquelin and Klaproth; while many new analyses have been made for this edition by Mr. Hayes of Roxbury, Dr. C. T. Jackson and Mr. John H. Blake of Boston.

We understand that this volume, which is nearly all printed, will be published about the middle of April next. On its appearance we shall notice it again.

15. *Proceedings of the Boston Society of Natural History, taken from the Society's Records.* 8*vo*, *Boston*, *pp.* 128, *from Jan.* 6*th*, 1841, *to June* 21*st*, 1843.—This active society, whose useful labors have frequently been noticed in our pages, has commenced the regular publication of its proceedings. The abstracts of papers are ably reduced, and show that the society has an uncommon number of *working resident* members, as well as active correspondents. We have no room to quote *all* the passages which we had marked for extraction, in these "proceedings." On p. 101, Mr. Teschemacher makes an interesting communication on the origin of the valuable manure called Guano, from the sea islands off the coast of Peru. We extract the passage.

"With reference to the opinion, entertained by some, that the Guano had been accumulating from a period perhaps prior to the origin of the human race, Mr. T. translated the following passage from the 'Memoriales Riales' of 'Garcilasso de la Vega.' Lisbon, 1609, p. 102. 'On the sea-coast, from below Arequipa as far as Tarapaca, which is more than two hundred leagues of coast, they use no other manure than that of marine birds, which exist on all the coast of Peru, both great and small, and go in flocks perfectly incredible, if not seen. They are reared on some uninhabited islands which exist on that coast, and the manure that they leave is of inconceivable amount. At a distance the hills of it resemble the mounds on some snowy plain. In the time of the Incas there was so much vigilance in guarding these birds, that, during the rearing season, no person was allowed to visit the islands under pain of death, in order that they might not be frightened and driven from their nests. Neither was it allowed to kill them at any time, either on or off of the islands, under the same penalty.' Each district or territory also had a portion of these islands allotted to it, the penalties for infringement of which were very severe. From this extraordinary care it is probable that the Incas did not permit any remarkable consumption of this valuable manure beyond the annual additions; and the consumption during the depopulation of South America by the Spaniards could, by no means, have equalled those annual deposits. Even the greatest thickness of seven to eight hundred feet might, without extravagant calculation, be deposited in about three thousand years at the rate of two or three inches a year. The feathers do not appear different from those of birds of the present day. Mr. Blake, a member of our society, who has visited these deposits, has a shell found in the Guano, very much resembling the *Crepidula fornicata* of this coast, but not in any way fossilized. On this coast it never rains, so that the deposits of manure are not, like those on other coasts, annually washed away."

We have just received the new number of the society's Journal, containing several interesting and valuable papers, particularly on the ichthyology of the North American lakes, by Dr. J. P. Kirtland, and on the fishes of Brookhaven, L. I., by Mr. Ayres.

16. *Proceedings of the American Philosophical Society, held at Philadelphia, for promoting Useful Knowledge.* Vol. III, (celebration of the hundredth anniversary.)—We have already given (Vol. XLV, page 231) a list of the papers read before the American Philosophical Society on the occasion of its hundredth anniversary in May last. This stout pamphlet of 228 pages contains excellent abstracts of those papers, mostly from the accurate pen of the reporter, (Prof. Bache.) Several of the most interesting papers read on this occasion have already appeared *in extenso* in our pages—e. g. by Messrs. Walker and Kendall, on the Great Comet of 1843, (Vol. XLV, p. 188;) by Mr. Redfield, on the Tides and Currents of the Ocean, (Vol. XLV, p. 293;) by Prof. Norton, on the Tails of Comets, (p. 104 of the present number.) Many of the geological notices have also appeared under various heads, and we shall probably have occasion to lay other valuable matter from the same source before our readers. The meeting was one of remarkable interest, and equally remarkable for the number of valuable original memoirs and discussions which it developed.

17. *Sketch of the Analytical Engine invented by Charles Babbage, Esq.* By L. F. Menabrea of Turin, Officer of the Military Engineers; with notes by the translator. (Extracted from the Scientific Memoirs, Vol. 3.) London, 1843.—It is well known that in 1823 the British government undertook to construct a calculating engine invented by Mr. Babbage. This machine was designed to compute and print off tables of many different kinds, particularly such as are wanted for the uses of astronomy and navigation. The calculations were to be performed by the successive addition of finite differences, a method which admits of rigorous exactness, only where all the differences after a certain order (in Mr. B.'s machine the seventh) disappear, but which in many other cases is able to furnish within certain limits results accurate enough for every practical purpose. The construction of this machine, after ten years' labor and an expenditure of £17,000, was discontinued in 1833, and has never since been resumed. Shortly after this interruption, Mr. Babbage conceived the plan of a machine essentially different from his first, possessing all its powers, and others vastly more important; which, instead of being confined to arithmetical addition, should be able to add, subtract, multiply, divide, calculate powers and roots, in any required order of succession, and in strict obedience to the laws of algebraical combination. Of this stupendous invention Mr. Menabrea has given us an account, remarkable for its clearness, and, so far as it goes, satisfactory. Avoiding all detail, he presents in distinct though general outline, the plan of the machine, and its mode of operation. Much valuable information and explanation are supplied by the copious notes of the translator.

## MISCELLANIES.

### DOMESTIC AND FOREIGN.

1. *Dr. Percival, the original observer of the crescent-formed Dykes of Trap in the New Red Sandstone of Connecticut.*—At the last meeting of the Association of American Geologists and Naturalists, held at Albany, in May, 1843, a discussion arose on the *cause* of the crescent form observed by Dr. Percival in the trap dykes of the Connecticut sandstone, and by Prof. H. D. Rogers in the same formation in New Jersey. A condensed summary of this discussion is given on page 334, Vol. XLV, of this Journal.

Prof. Rogers introduced his remarks by saying, that his attention had been arrested on examining the singularly accurate and beautiful map by Dr. Percival, published in his Report on the Geology of Connecticut, by the fact, that the points of the crescents in that State were all turned in a generally southwest direction, the dip of the strata being northeasterly; while on the contrary in New Jersey, the opposite direction was observed both in the dip and the points of the crescents. In the abstract referred to, desiring to make the matter as condensed as possible, consistently with clearness, I left out the above allusion to Dr. Percival's report, and the fact, (well known to all acquainted with New England geology,) that Dr. Percival was the *original observer* of this important feature in our trap system, and confined the report simply to a concise statement of the outlines of the *theory* proposed, to account for the form observed, taking the fact and the original observation to be well known. I have been informed since the appearance of this abstract, that it wears a coloring of injustice to Dr. Percival, as the *original observer of the facts*, and their most acute and laborious expounder—since no reference was made to him in the report alluded to. Nothing could have been farther from my thoughts and intentions, than any shadow of injustice to Dr. Percival; but I freely acknowledge, that on a second perusal of the discussion in question, I can see that it would have been better to have made the allusion to Dr. Percival's discovery, contained in the first part of this note.

Meantime I would say, that it is a subject of much regret with all who are interested in the question, that Dr. Percival has not given us his theoretical and practical views on this subject, in a shape more enduring and extended, than casual conversation with his scientific friends, and verbal communications to the Connecticut Academy of Arts and Sciences.* In his very accurate Report already alluded to, Dr. Percival has felt obliged to confine himself almost entirely to the facts observed, and has dealt very sparingly in those general conclusions which might very legitimately be drawn from them, and which he is so able to give. It is our intention to insert in an early number of this Journal, a review of Dr. Percival's Report, and to accompany it by the map of the district examined, from which geologists can form a better notion of the subject of the present note. B. Silliman, Jr.

Yale College Laboratory, New Haven, Dec. 25, 1843.

2. *Method of separating the Oxides of Cerium and Didymium;*† by L. L. Bonaparte.‡—I had been for some time occupied with the study of several metallic valerianates,§ especially that of the oxide of cerium,

* The earliest of which was communicated to this society, Dec. 25, 1834.

† From διδυμος, *twin.*

‡ Translated from Poggendorff's Annalen, Vol. lix, p. 623. The original appeared in the Comptes Rendus, T. 16, p. 1008.

§ Valerianic acid is obtained from the roots of *Valeriana officinalis.* It forms a large and well characterized class of salts with metallic oxides.—*Eds.*

when I became acquainted, through the medium of the scientific journals, with Mosander's discovery of didymium.* It has been my good fortune to discover, in a concentrated solution of valerianic acid, the means of separating the oxide of cerium in a state of purity. Valerianic acid possesses a remarkable and unexpected affinity for the oxide of cerium, inasmuch as it precipitates it abundantly from a concentrated solution in nitric acid, containing at the same time oxide of didymium. The yellowish-white precipitate consists merely of the valerianate of the oxide of cerium, and it is only requisite to wash it well and to submit it to a strong heat without exposure to the air, to obtain the oxide of cerium in a state of purity. This oxide is of a very pale yellow color, similar to that oxide as prepared by Mosander, who however confesses that he has not hitherto succeeded in discovering a method of separating from each other completely the oxides of cerium, lanthanum and didymium.

The oxide of didymium remains in solution in the acid fluid from which the oxide of cerium has been precipitated. A portion of the latter oxide remains, however, associated with that of didymium; for the valerianates of both these metals are to a certain extent soluble in water, and even more so in acidulated fluids, the oxide of didymium especially, which is far more easily soluble in weak acids than that of cerium. By means of valerianic acid, however, the oxide of didymium may be obtained in a state of purity, though not so readily as the oxide of cerium.

I have only to remark, in conclusion, that to obtain the valerianate of the oxide of cerium in a state of purity from the nitric solution of the mixed oxides of cerium and of didymium, this salt must be precipitated by an aqueous concentrated solution of valerianic acid;—with a soluble valerianate the didymium would be thrown down at the same time, inasmuch as the latter, when in the form of a valerianate, is but sparingly soluble in neutral solutions. It is therefore upon the ready solubility of the valerianate of the oxide of didymium in acidulous solutions, and upon the inferior solubility of the analogous salt of the oxide of cerium, that the simple preparation of the oxide of cerium in a state of purity is based.

3. *Sillimanite and Monazite.*—These two minerals which are associated in the localities at Norwich and Chester (Saybrook) in Connecticut, have recently been found together in a quarry in Yorktown, Westchester County, N. Y., by Mr. I. Mekul. They are there associated with *magnetic iron* and *quartz*, and the crystals of *Sillimanite* often penetrate this mineral for several inches. Mr. M. remarks, in a letter to me dated Nov. 21, that they are frequently six or more inches in length, much

* American Journal of Science, Vol. XLIII, p. 404.

bent and fractured, as they are at Norwich and Chester. The *Monazite* from this locality is in very perfect, transparent prisms, with a simple pyramidal termination; they are small, rarely exceeding one eighth of an inch in length, and are scattered like small garnets through the brown quartz adjoining the *magnetic iron.* I have seen none of them *in* the latter gangue. As the Yorktown quarry is to be worked for the *iron*, we may hope for a supply of these two rather rare species.

In 1841, Mr. Arthur Connell* published an analysis of *Sillimanite*, from which he was led to associate this species with *disthene* (*kyanite*); his analysis substantially confirms Mr. Bowen's,† and the two are certainly inconsistent with that of Dr. Thomson's,‡ in which zirconia was found to be so large a constituent, (18 per cent.) Yet it is singular that in the analysis of Dr. Thomson's pupil, (Mr. Muir,) the sum of the silica, alumina, and zirconia, (=92·86,) should have so nearly equalled the silica and alumina in Mr. Bowen's analysis, 96·777. As small *zircons* are not uncommonly found associated with *Sillimanite* at Norwich, (although I have never seen them at Chester, from whence Dr. Thomson's specimens, and Mr. Connell's, were derived,) it is certainly possible that a portion of this species was mixed with the subject of analysis; otherwise it is difficult to understand what the mineral analyzed by Muir was. Among the specimens personally obtained at various times at Norwich, I have found one crystal with terminating planes, which, together with the characteristic diagonal cleavage of Sillimanite, is irreconcilable with the view of Mr. Connell—drawn from his own and Mr. Bowen's analysis—that this mineral is identical with disthene or kyanite.

B. Silliman, Jr.

4. *The great Telescope of the Earl of Rosse.*—We have been frequently indebted to our esteemed friend and correspondent, John Taylor, Esq. of Liverpool, for information respecting the progress of the largest telescope in the world. The following statement of facts respecting this telescope, is cited from the London News, illustrated, of Sept. 9, 1843, kindly forwarded to us by Mr. Taylor.§ It is now in progress at Parsonstown, Ireland, the seat of the earl of Rosse in King County, eighty seven miles from Dublin.

This nobleman appears to love science for its own sake, and in him talents of a high order are united with great perseverance and prac-

* Jameson's New Edinburgh Phil. Jour., Vol. xxxi, p. 232; entire No. 62.

† Am. Jour., Vol. viii, p. 113.

‡ Edinburgh Transactions, Vol. xi, 245, and Outlines of Mineralogy, Vol. i, 424.

§ The illustrations of various subjects in wood cuts are very beautiful, and every way worthy of being preserved in a more permanent form. A large portion of them are designed to immortalize the recent travels of the youthful British Queen and Prince Albert.

tical good sense. He has been working silently on, until the attention of the world is arrested by the magnitude of the result in the production of metallic reflectors of a size heretofore unknown. Until he demonstrated the contrary, it was thought impossible to cast a speculum of six feet in diameter. As a preliminary to his present gigantic work, there has been exhibited during the last ten or twelve years on the earl of Rosse's lawn, a reflecting telescope made by himself, with a mirror of three feet diameter, and a focal length of twenty seven feet. It is suspended by a frame-work similar, at least, if we may judge from the figure, to that of Dr. Herschel's great telescope.

Being in equilibrio, it is managed with the greatest facility. The casting, grinding, and polishing of these specula, and the machinery of the tubes and their suspension, were all accomplished under his lordship's eye and by his own direction. According to lord Rosse's experience, the only metals that can be employed in forming specula, are copper and tin, and the proportions should be, tin 58·9, and copper 126·4, or very nearly 3 of tin and 7 of copper.

Of these metals, for his large speculum, he melted three tons in three cast iron crucibles—crucibles of this metal cast with their mouths upward having been found the best. Each crucible containing a ton of metal was placed in a distinct furnace, and for nineteen hours subjected to an intense heat. The crucibles were lifted by an immense crane from their furnaces, and at nine in the evening of April 18, 1842, without accident or delay, they simultaneously poured forth their glowing contents, a burning mass of fluid matter, hissing, heaving, pitching itself about for a minute, and then calmly settling forever into a monument of man's industry and skill. When the metal had settled, it was drawn by a capstan into a heated oven and built in, where it remained for sixteen weeks annealing. The great difficulty experienced in producing large reflectors is, that in cooling, the metal generally cracks; and when this does not occur, the number of holes often found in the solid mass renders it of no use. Lord Rosse has the merit of having overcome both of these difficulties in a manner hereafter to be described in a distinct work. By an ingenious combination of motions, lord Rosse effected the difficult object of producing a parabolic figure on a large scale. It required six weeks to grind the speculum to a fair surface. The grinding tools being covered with pitch and sprinkled over with crocus, answered for polishing—nothing else being necessary —some precautions being observed to prevent an unequal action.

The tube in which the speculum is to be mounted, is fifty two feet long and seven feet in diameter, sufficiently large to receive a platoon of soldiers. This tube is of wood hooped with iron; it was constructed in a long gallery over a range of outhouses, which were thrown down to admit of its removal. It is expected that this enormous instrument will be moved about and regulated by one man's arm, and placed in its position with the greatest ease and certainty. The walls destined to support the machinery, are built exactly in the meridional line, so that the telescope which will lie between them will take in objects only as they pass the meridional line; they can be kept in view for half an hour on each side of the meridian. As already intimated, the speculum is six feet in diameter, and the focal distance is fifty two feet. It will render visible a portion of the moon of the size of a common house. Lord Rosse has erected an equatorial instrument, the largest ever constructed. It is eighteen inches in diameter, and by its peculiar mechanism, the truest ever used. It is stated, that Sir James South laid out seven thousand pounds in erecting one which did not answer, and was afterwards broken up.

5. *Third Comet of* 1843.—A telescopic comet was discovered, November 22d, 1843, at 1h. A. M., near the star $\gamma$ *Orionis*, by M. Paye, an astronomer attached to the Royal Observatory, at Paris. Notwithstanding the clouds and vapors which impeded the view, the place of the comet was found to be as follows: Nov. 22, 1843, 14h. 44m. 11s. Paris mean time, R. A. 81° 5′; N. decl. 6° 56′. On account of clouds, the comet was not again seen until the 24th, when its position was accurately determined, as follows: Nov. 24, 1843, 17h. 14m. 43s. Paris mean time, R. A. 80° 50′ 42″; N. decl. 6° 30′ 35″;—the apparent right ascension having diminished seven minutes of arc within about twenty-four hours, and the north declination having also diminished twelve minutes. The nucleus of this comet is so distinct, as to permit very precise observations. From the nucleus faint trains of light diverge nearly opposite to the sun; the entire tail being about four minutes in length.

Dr. South adds that the comet was observed by him, at his observatory at Kensington. Seen through the large achromatic of 11·9 inches diameter, with powers of 150 and 300, the nucleus seemed not round, but elongated in the direction of the tail, which latter, after moonset, extended about eleven minutes of arc. It does not bear much illumination of the field, although it was easily found with an achromatic telescope of 2·75 inches aperture. Its approximate place, November 30, 1843, at 48m. 37s. after midnight, was in R. A. 5h. 21m. 37s. N. decl. 5° 34′ 32″, very near the star A *Orionis.*—*New York Journal of Commerce, from a London paper.*

6. *Remarkable Fulgurite.*—M. Fiedler presented to the Academy of Sciences a fulgurite remarkable for its size and preservation. We make

the following extract relating to the discovery of this "tube fulminaire." On the 13th of June, 1841, at 5, P. M., a storm arose up the course of the Elbe, passing over the sand hills which are covered with vineyards, on the right bank of that river, near the village of Loschwitz, one league from Dresden. Believing the lightning to have struck the pavilion in which Schiller wrote his Don Carlos, they ran to the top of the hill; but fifty steps before arriving at this building, a split support of a vine indicated that lightning had struck here. M. Fiedler gave notice to the proprietor of the vineyard, remarking with surprise the near proximity of a plum tree, which he supposed from its height would have sooner attracted the electric fluid. Be that as it may, on tracing the direction of the fulgurite, they saw that it forced itself into the earth at an inclination of 66°; it met some small roots of the plum, which though containing more moisture than the surrounding gravel, and running in nearly the same direction with the electric spark, (as could be seen in the specimen before the Academy,) were only blackened in the parts surrounded by the tube and immediately contiguous—the heat, though enormous, having passed too suddenly to carbonize the wood. At one metre from the upper part, the fulgurite is divided into three long branches, each about sixty-five centimetres. It was stated on the spot, that these roots disappear in a bed of very moist argillaceous and ferruginous sand.—*Comptes Rendus*, 31*st July*, 1843.

7. *Upon the deposit of Gold recently discovered in the Ural.**— The mass of gold recently discovered in the Ural is the largest known in the whole world. It was found in the gold-bearing sands of Miask in the district of Zlatooust, not far from the celebrated mines of Tzarevo Nikolæfsk, and of Tzarevo Alexandrofsk in the southern Ural. These two mines which you have visited with so much interest, have already yielded as you are aware nearly 400 "pouds" of gold (6552 kil.) equal to about 17,544·5 lbs., and more than once very remarkable masses have been collected there. Thus in 1825 they found there the specimen weighing 24 phounds, 68 zolotniks (10 kil. 118,) about 27·017 lbs. However, these mines beginning to be exhausted, they were compelled to make explorations near the course of the river Tachkou-Targanka, which soon led to the discovery of a bed of gold-bearing sands of very great richness, but within very narrow limits. This bed once found, they turned off the stream, which had served for washing the sands, up the whole length of this river, and commenced their examinations in the dry bed of the stream. Their success was complete.

* Extract of a letter from M. de Kokcharoff, officer of the Royal Mining Company, to M. de Humboldt. Translated from the Annales des Mines, 4th series, tome 3, liv. 1, p. 51, 1843.

They came at once upon a stratum of gold-bearing sands of considerable extent, where the yield of gold was 100 pouds to 8 zolotniks, (a very great proportion, when it is remembered that sands giving 100 pouds to 1½ zolotniks have been before considered well worth exploring.) Then other beds were discovered of a yet greater capacity, which terminated in the examination of the whole valley of the Tachkou-Targanka, with the exception of the spot occupied by the buildings necessary for the washings. In the course of 1842 they pushed the works under the foundations of the building. The first attempts were not successful, but they soon came upon a spot of marvellous richness, where the yield was from 50 to 70 zolotniks of gold in one poud of sand. Its extent was however very limited. At last, on the 26th of October, 1842, they found this monstrous mass, weighing 2 pouds, 7 phounds, and 92 zolotniks, (36 kil. ·020758,) 100·078 lbs. It lay upon the strata of diorite* in the bed of gold sand, at the depth of 4½ *archines* from the surface and under the corner of the building.

The mass in question has already reached St. Petersburgh, and is placed at the museum of the Institute of Mining Engineers.† A discovery which is equally worthy of our attention, is that of a bed of gold-bearing sands on the left bank of the same river before the dike, containing a considerable number of masses; already they have taken thence 52, weighing each from one to seven pounds Russian.

*Note by M. Humboldt.*—The largest piece of platina found up to this time at Nijni Tageulsg weighs 20 lbs. (Russian), 34 zolotniks. Piece of gold found at Miask, 10 kil. ·119 = 27.002 lbs. Piece of gold found in the United States, Anson County, N. C. 21·70 kil. = 57·939 lbs. Piece found at Rio Hayna, (1502,) and lost in the depths of the sea, (see my critical examination of the geography of the new continent,) 14·500 kil. = 38·715 lbs. Wonderful mass of Miask found 1842, 36·020 kil. = 100·077 lbs.

According to a letter from Count Cancrine, Dec. 3, 1842, Siberia to the east of the Ural produced in 1842 the quantity of 479 pouds of gold = 7·846 kilogrammes = 21,058 pounds, and the whole of Russia about 970 pouds = 15·889 kilogrammes = 42,323·63 pounds.

8. *Periclase, a new mineral.*—M. Scacchi, professor of mineralogy at Naples, has communicated to the *Annales des Mines*, through his

* A variety of trap.

† According to Kupffer, (Travaux de la commission des mesures et des poids dans l'empire de Russie, 1811, tome 1, p. 331,)

1 kil. = 2 pounds Russian, 42 zolotniks and 40·54 dolei. Then 1 poud = 16 kil., 381; 1 pound Rus. = 0 kil. ·4095; 1 poud = 40 lbs. Rus.; 1 lb. Rus. = 96 zolotniks; 1 zolotnik = 96 dolei; 1 archine = $0^{m}$ 711.

friend, M. Damour, a description of a mineral found in the ancient lavas of Vesuvius, of a vitreous appearance, obscure green color, and confused crystallization, imbedded in a calcareous gangue like the gehlenite of Fassa. It cleaves readily in three directions parallel to the faces of a cube, whence it derives its name, Periclase. It crystallizes in regular octahedrons, is infusible before the blowpipe. The powder is entirely soluble in acids. Hardness equal to feldspar. Specific gravity 3·75. It is composed of magnesia and a little oxide of iron. Its composition in 100 parts, is

| | First analysis. | Second analysis. |
|---|---|---|
| Magnesia, | 92·57 | 91·18 |
| Oxide of iron, | 6·91 | 6·30 |
| Insoluble matter, | ·86 | 2·10 |
| | 100·34 | 99·58 |

*Ann. des Mines*, *4th Series*, *Vol. III*, *p.* 369.

9. *Coast Survey.*—The death in November last of Mr. Hassler, the venerable and learned originator and conductor of the coast survey of the United States, left a vacant post, which has been filled to the universal satisfaction of the science of the country, by the appointment of Professor Alexander D. Bache as the successor of Mr. Hassler. No man in America could be found better qualified to carry through this great enterprise, combining as he does in an eminent degree the necessary scientific qualifications with great practical wisdom in the management of affairs and men, and possessing the unbounded confidence of all. It cannot be otherwise than gratifying to Prof. Bache, that he has been called to this post, as it were by the unanimous suffrages of his peers; for the entire body of science and learning in the country petitioned government for his appointment.

We understand that there is an intention of dividing the duties formerly performed by Mr. Hassler, and setting off the weights and measures in a separate department, over which is to be placed a gentleman eminently qualified to complete this subject, already in an advanced state.

10. *Canal around the Sault St. Marie to connect Lake Superior with Lake Huron.*—We observe that this important subject is agitated in Detroit, and that application is about being made to Congress for aid in effecting the work. The fall is twenty two feet, the length of the canal one mile, the estimated expense one hundred thousand dollars. An immense mining country, including the copper region, from which the great mass of native copper came, and which has now gone to Washington, lies around this vast fresh-water sea, whose length is be-

tween four hundred and five hundred miles, its breadth approaching one hundred and fifty miles, and its depth nine hundred feet.

It is in reference solely to the mineral, and other physical resources of the vast territory lying contiguous to its shores, that we feel it proper to mention the subject in this Journal, which has no relation to politics. We are free however to express our opinion that the general government ought at once to espouse this work, and give it a prompt and thorough execution, *at whatever cost.* It is due to the far west, to the near west, and even to the east, as the whole country is bound together by interests which justify and imperiously demand national aid to give them full activity, and thus to unite, by indissoluble ties, the most remote extremities of our immense empire—an empire which the people rule, and for the improvement of which the people are willing to pay.

11. *Destruction of the Public Conservatory at Boston.*—This valuable and beautiful collection of exotics, occupying a large circular domed conservatory, was totally destroyed by fire, which caught from one of the furnaces employed in heating the house; and although the flames were very soon extinguished, the escape of noxious gases and the entrance of cold air (14° F.) from without, soon ruined all that the house contained. This establishment was under the enlightened direction of Mr. J. E. Teschemacher, a gentleman whose scientific attainments are well known, and whose zeal in the department of horticulture and vegetable physiology, eminently qualified him for the post. He had at the time of the accident many interesting experiments in progress, especially on the subject of manures. The house contained the largest and most splendid plants of the Camellias and Rhododendrons in this country—the result of long years of judicious culture, and whose loss cannot soon be repaired. All the rare foreign birds in the conservatory also perished.

12. *The De Candolle prize for Botanical Monographs.*—The late Prof. De Candolle having bequeathed the sum of two thousand four hundred francs, in trust, to the *Société de Physique et d'Histoire Naturelle de Genève*, the interest of which is to be awarded, from time to time, as a premium for botanical monagraphs,* that society announces,

1. That, on the 9th of September, 1846, it will award a premium of five hundred francs to the author of the best monograph of a genus or family of plants.

2. The premium is open to the competition of all naturalists, without distinction, except the ordinary members of the society that holds the

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* Vide American Journal, Vol. XLIV, p. 23.

trust. Candidates are desired to transmit their memoirs, written either in French or in Latin, previous to July 1st, 1846.

The society will probably publish the monograph of the successful candidate in its Memoirs, (nine volumes of which have already appeared,) but does not pledge itself to do so.

13. *Effect of Electricity.**—My house was struck by lightning a few weeks ago, during a violent rain. The electric fluid followed a spout filled with water into a cistern, out of which a stream was flowing, thus affording a conductor to the earth. Yet the outer circumference of the cistern was torn into splinters, the fluid having passed outward through the staves. The largest splinters extended from one to another of the iron hoops of the vessel, which were slightly fused at a number of points.

14. *Proposed nomenclature of numbers between ten and twenty.*—The anomalous character of our nomenclature of the numbers between ten and twenty, has often been observed and lamented. It has been frequently seen to be a source of impediment to the young learner, and has often defied the skill of the more advanced to explain.

Several alterations have been suggested—such as "*one ten*, *two ten*," for eleven and twelve—also, "*ten one*, *ten two*, *ten three*," &c. Without enlarging upon the merits or demerits of these alterations, I will come directly to the one I wish to propose, which is, for eleven, twelve, thirteen, &c., to use *onety one*, *onety two*, *onety three*, &c. Aside from its novelty, there can be no more objection to abridging the expression one ten into *onety*, than that of two tens into twenty, three tens into thirty, &c. This alteration would bring the nomenclature of this decade into perfect analogy with that of the subsequent ones, and thus deliver the system from a great stumbling block of offense. D.

New Haven, Dec. 1, 1843.

15. *Heat from solid carbonic acid.*—There is a remarkable reaction between solid carbonic acid and the caustic alkalies. If a small piece of solid carbonic acid be wrapped in cotton with a little pulverized caustic potash, and the whole be pressed between the fingers, so much *heat* is evolved as to make it uncomfortable to hold. This is the most remarkable illustration of heat from chemical union. One of the agents employed is the coldest substance in nature, with which we are acquainted, that which we select to show the effects of extreme refrigeration. The other is at the natural temperature. Both

* Extract of a letter from S. S. Haldeman, Esq., dated Marietta, Pa., Sept. 15, 1843.

moreover are in the dry or solid state. Yet their union or simple contact produces heat, sufficient at least, to inflame phosphorus.

This reaction is noticed, as its suggests some striking experiments. It has very possibly been observed by others, though it is not referred to in various works on the subject. Wm. F. Channing.

Boston, May 2, 1843.

16. *Death of Dr. Richard Harlan.*—This gentleman, whose papers have so frequently appeared on our pages, died at New Orleans, La., in October last, but of the particulars of his death, and his age, we know nothing.

17. *Death of Col. Trumbull.*—The venerable patriot, artist, and friend of Washington—the father of American historical painting—died at New York, Nov. 10, 1843, and was interred at New Haven in his own stone tomb, beneath the Trumbull gallery of pictures. (See Vol. xxxix, of this Journal.) His autobiography was published two years ago, in a beautifully illustrated volume. He was nearly half through his 88th year.

18. *Death of the Rev. James H. Linsley.*—It is with sincere regret that we record the death of this amiable and excellent man, which took place on Tuesday morning the 26th of December, at his residence at Elmwood Place, Stratford, Conn., at the age of 56 years. Mr. Linsley was a clergyman of the Baptist persuasion, and continued in the active duties of his calling until about ten years since, when the failure of his health obliged him to seek other intellectual employment; and he found great solace and pleasure in a devoted attachment to the several branches of natural history, particularly ornithology, conchology, ichthyology and herpetology. His life was sustained by a beautiful enthusiasm, which carried him successfully through labors to which his bodily health was inadequate. How much he accomplished toward a knowledge of the natural history of his native state, may be judged of by referring to his papers published in this Journal. His last, on the Fishes of Connecticut, completed only a few days before his death was intended for our April number. His catalogue of the Mammalia of Connecticut, is in Vol. xliii, p. 345; of the Birds, Vol. xliv, p. 249; of the Reptiles, p. 37 of the present number.

Mr. Linsley has left extensive collections in several departments of natural history, besides valuable unpublished notes.

THE

# AMERICAN

# JOURNAL OF SCIENCE, &c.

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Art. I.—*Description of the Tithonometer, an instrument for measuring the Chemical Force of the Indigo-tithonic Rays;* by John W. Draper, M. D., Professor of Chemistry in the University of New York.*

I have invented an instrument for measuring the chemical force of the tithonic rays which are found at a maximum in the indigo space, and which from that point gradually fade away to each end of the spectrum. The sensitiveness, speed of action and exactitude of this instrument, will bring it to rank as a means of physical research with the thermo-multiplier of M. Melloni.

The means which have hitherto been found available in optics for measuring intensities of light, by a relative illumination of spaces or contrast of shadows, are admitted to be inexact. The great desideratum in that science is a photometer which can mark down effects by movements over a graduated scale. With those optical contrivances may be classed the methods hitherto adopted for determining the force of the tithonic rays by stains on Daguerreotype plates or the darkening of sensitive papers. As deductions, drawn in this way, depend on the *opinion* of the observer, they can never be perfectly satisfactory, nor bear any comparison with thermometric results.

Impressed with the importance of possessing for the study of the properties of the tithonic rays some means of accurate meas-

* From the London, Edinburgh and Dublin Philosophical Magazine and Journal of Science, for December, 1843.

urement, I have resorted in vain to many contrivances; and, after much labor, have obtained at last the instrument which it is the object of this paper to describe.

The tithonometer consists essentially of a mixture of equal measures of chlorine and hydrogen gases, evolved from and confined by a fluid which absorbs neither. This mixture is kept in a graduated tube, so arranged that the gaseous surface exposed to the rays never varies in extent, notwithstanding the contraction which may be going on in its volume, and the muriatic acid resulting from its union is removed by rapid absorption.

The theoretical conditions of the instrument are therefore sufficiently simple; but, when we come to put them into practice, obstacles which appear at first sight insurmountable are met with. The means of obtaining chlorine are all troublesome; no liquid is known which will perfectly confine it; it is a matter of great difficulty to mix it in the true proportion with hydrogen, and have no excess of either. Nor is it at all an easy affair to obtain pure hydrogen speedily, and both these gases diffuse with rapidity through water into air.

Without dwelling further on the long catalogue of difficulties which is thus to be encountered, I shall first give an account of the capabilities of the instrument in the form now described, which will show to what an extent all those difficulties are already overcome. In a course of experiments on the union of chlorine and hydrogen, some of which were read at the last meeting of the British Association, I found that the sensitiveness of that mixture had been greatly underrated. The statement made in the books of chemistry, that artificial light will not affect it, is wholly erroneous. The feeblest gleams of a taper produce a change. No further proof of this is required than the tables given in this communication, in which the radiant source was an oil lamp. For speed of action no tithonographic compound can approach it; a light, which perhaps does not endure the millionth part of a second, affects it energetically, as will be hereafter shown.

*Proofs of the sensitiveness of the Tithonometer.*—The following illustrations will show that the tithonometer is promptly affected by rays of the feeblest intensity, and of the briefest duration.

When, on the sentient tube of the tithonometer, the image of a lamp formed by a convex lens is caused to fall, the liquid instantly begins to move over the scale, and continues its motion as long as the exposure is continued. It does not answer to expose the tube to the direct emanations of the lamp without first absorbing the radiant heat, or the calorific effect will mask the true result. By the interposition of a lens this heat is absorbed, and the tithonic ràys alone act.

If a tithonometer is exposed to daylight coming through a window, and the hand or a shade of any kind is passed in front of it, its movement is *in an instant* arrested; nor can the shade be passed so rapidly that the instrument will fail to give the proper indication.

The experimenter may further assure himself of the extreme sensitiveness of this mixture by placing the instrument before a window, and endeavoring to remove and replace its screen so quickly that it shall fail to give any indication; he will find that it cannot be done.

Charge a Leyden phial, and place the tithonometer at a little distance from it, keeping the eye steadily fixed on the scale; discharge the jar, and the rays from the spark will be seen to exert a very powerful effect, the movement taking place and ceasing in an instant.

This remarkable experiment not only serves to prove the sensitiveness of the tithonometer, but also brings before us new views of the powers of that extraordinary agent, electricity. That energetic chemical effects can thus be produced at a distance by an electric spark in its momentary passage, effects which are of a totally different kind from the common manifestations of electricity, is thus proved; these phenomena being distinct from those of induction or molecular movements taking place in the line of discharge, they are of a radiant character, and due to the emission of tithonicity; and we are led at once to infer that the well known changes brought about by passing an electric spark through gaseous mixtures, as when oxygen and hydrogen are combined into water, or chlorine and hydrogen into muriatic acid, arise from a very different cause than those condensations and percussions by which they are often explained, a cause far more purely chemical in its kind. If chlorine and hydrogen can be made to unite silently by an electric spark passing outside the vessel which contains them, at a distance of several inches, there is no difficulty in understanding why a similar effect should take place with a violent explosion when the discharge is made through their midst; nor how a great many mixtures may be made to unite under the same treatment. A flash of lightning cannot take place, nor an electric spark be discharged, without chemical charges being brought about by the radiant matter emitted.*

*Proofs of the exactness of the indications of the Tithonometer.*—The foregoing examples may serve to illustrate the extreme sensitiveness of the tithonometer; I shall next furnish proofs that its indications are exactly proportional to the quantities of light incident on it.

As it is necessary, owing to the variable force of daylight, to resort to artificial means of illumination, it will be found advantageous to employ the following method of obtaining a flame of suitable intensity.

Let A B, fig. 4, be an Argand oil-lamp, of which the wick is C. Over the wick, at a distance of half an inch or thereabouts, place a plate of thin sheet copper, three inches in diameter, perforated in its centre with a circular hole of the same diameter as the wick, and concentric therewith. This piece of copper is represented at *d d*; it should have some contrivance for raising or depressing it through a small space, the proper height being determined by trial. On this plate, the glass cylinder *e*, an inch and three quarters in diameter and eight or ten inches long, rests.

When the lamp is lighted, provided the distance between the plate *d d* and the top of the wick is properly adjusted, on putting on the glass cylinder the flame instantly assumes an intense whiteness; by raising the wick it may be elongated to six inches or more, and becomes exceedingly brilliant. Lamps constructed on these principles may be purchased in the shops. I have, however, contented myself with using a common Argand study-lamp, supporting the perforated plate *d d* at a proper altitude by a retort

* Since the above was printed in London, I have found that there is no difficulty in making chlorine and hydrogen *explode*, by passing the spark from a Leyden jar of the capacity of a quart, *outside the sentient tube of the instrument*. This result therefore confirms the views here expressed, that combinations ensuing on the passage of an electric spark are not entirely due to any such mechanical agency as condensation or percussion, but to the action of the radiant matter emitted. I believe it will be found, that the explosive union of oxygen and hydrogen by an electric discharge is a phenomenon of the same kind.

stand. It will be easily understood that the great increase of light arises from the circumstance that the flame is drawn violently through the aperture in the plate by the current established in the cylinder.

As much radiant heat is emitted by this flame, in order to diminish its action, and also to increase the tithonic effect, I adopt the following arrangement. Let A B, fig. 4, be the lamp; the rays emitted by it are received on a convex lens D, four inches and three quarters in diameter, that which I use being the large lens of a lucernal microscope. This, placed at a distance of twenty one inches from the lamp, gives an image of the flame at a distance of thirteen inches, which is received on the sentient tube of the tithonometer F; between the tithonometer and the lens there is a screen E.

Things being thus arranged, and the lamp lighted so as to give a flame about three inches and a half long, we may proceed with the experiments. It is convenient always to work with the flame at a constant height, which may be determined by a mark on the glass cylinder. At a given instant, by a seconds watch, the screen E is removed, and immediately the tithonometer begins to descend. When the first minute is elapsed the position on the scale is read off and registered; at the close of the second minute the same is done, and so on with the third, &c. And now, if those numbers be compared, casting aside the first, they will be found equal to one another, as the following table of experiments, made at different times and with different instruments, shows:—

Table I.—*Showing that when the radiant source is constant, the amount of movement in the tithonometer is directly proportional to the times of exposure.*

| Time. | Experiments. | | | | |
|---|---|---|---|---|---|
| | 1. | 2. | 3. | 4. | 5. |
| 30″ | 7·00 | 7·00 | 10·25 | . . | 5·25 |
| 60 | 8·00 | 7·75 | 11·50 | 11·75 | 6·50 |
| 90 | 7·50 | 8·00 | 11·50 | . . | 6·25 |
| 120 | 7·75 | 7·75 | 11·50 | 13·00 | 6·00 |
| 150 | 7·75 | 7·25 | . . | . . | 6·00 |
| 180 | . . | . . | . . | 12·00 | 6·00 |
| 210 | . . | . . | . . | . . | 6·00 |
| Mean | 7·60 | 7·55 | 11·19 | 12·25 | 6·00 |

From this it will be perceived that, taking the first experiment as an example, if at the end of 30″ the tithonometer has moved 7·00, at the end of 60″ it has moved 8·00 more, at the end of 90″, 7·50 more, at the end of 120″, 7·75 more; the numbers set down in vertical column representing the amount of motion for each thirty seconds. And, when it is recollected that the readings are all made with the instrument in motion, the differences between the numbers do not greatly exceed the possible errors of observation. It may be remarked that the third and fourth experiments were made with a different lamp.

Though a certain amount of radiant heat from a source so highly incandescent as that here used will pass the lens, its effects can never be mistaken for those of the tithonic rays. This is easily understood, when we remember that the effect of such transmitted heat would be to expand the gaseous mixture, but the tithonic effect is to contract it.

Next, I shall proceed to show that the indications of the tithonometer are strictly proportional to the quantity of rays that have impinged upon it; a double quantity producing a double effect, a triple quantity a threefold effect, &c.

A slight modification in the arrangement (fig. 4) enables us to prove this in a satisfactory way. The lens D, being mounted in a square wooden frame, can easily be converted into an instrument for delivering at its focal point, where the sentient tube is placed, measured quantities of the tithonic rays, and thus becomes an invaluable auxiliary in those researches which require known and predetermined quantities of tithonicity to be measured out. The principle of the modification is easily apprehended. If half the surface of the lens be screened by an opake body, as a piece of blackened card-board, of course only half the quantity of rays will pass which would have passed had the screen not been interposed. If one fourth of the lens be left uncovered, only one fourth of the quantity will pass; but in all these instances the focal image remains the same as before. By adjusting, therefore, upon the wooden frame of the lens, two screens, the edges of which pass through its centre, and are capable of rotation upon that centre, we shall cut off all light when the screens are applied edge to edge, we shall have 90° when they are rotated so as to be at right angles, and 180° when they are superposed with their edges parallel. Thus by setting them in different angular positions, we can gain all quantities from 0° up to 180°, and by removing them entirely away reach 360°.

It will be understood that the effect of the instrument is to give an image of a visible object, of which the intensity can be made to vary at pleasure in a known proportion.

In order therefore to prove that the indications of the tithonometer are proportional to the quantity of impinging rays, place this *measuring lens* in the position D, setting its screens at an angle of 90°. Remove the screen E, and determine the effect on the tithonometer for one minute. At the close of the minute, and without loss of time, turn one of the screens so as to give an angle of 180°, and now the effect will be found double what it was before, as in the following table.

TABLE II.—*Showing that the indications of the tithonometer are proportional to the quantity of incident rays.*

| Quantities. | Experiment I. | | Experiment II. | |
|---|---|---|---|---|
| | Observed. | Calculated. | Observed. | Calculated. |
| 90° | 2·18 | 2·22 | 2·69 | 2·75 |
| 180 | 4·27 | 4·45 | 5·75 | 5·50 |
| 270 | 6·70 | 6·67 | 8·25 | 8·25 |
| 360 | 8·90 | 8·90 | 11·00 | 11·00 |

I have stated in the commencement of this paper, that the action upon the tithonometer is limited to a ray which corresponds in refrangibility to the indigo, or rather, that in the indigo space its maximum action is found. The following table serves at once to prove this fact, and also to illustrate the chemical force of the different regions of the spectrum.

TABLE III.—*Showing that the maximum for the tithonometer is in the indigo space of the spectrum.*

| Space. | Ray. | Force. | Space. | Ray. | Force. |
|---|---|---|---|---|---|
| 0 | Extreme red, | ·33 | 8 | Blue indigo, | 204·00 |
| 1 | Red, | ·50 | 9 | Indigo, | 240·00 |
| 2 | Orange, | ·75 | 10 | Violet, | 121·00 |
| 3 | Yellow, | 2·75 | 11 | Violet, | 72·00 |
| 4 | Green, | 10·00 | 12 | Violet, | 48·00 |
| 5 | Green-blue, | 54·00 | 13 | Violet, | 24·00 |
| 6 | Blue, | 108·00 | 14 | Extra spectral, | 12·00 |
| 7 | Blue, | 144·00 | | | |

In this table the spaces are equal; the centre of the red, as insulated by cobalt blue glass, is marked as unity; the centre of the yellow, insulated by the same, being marked 3; the intervening region being divided into two equal spaces, and divisions of the same value carried on to each end of the spectrum.

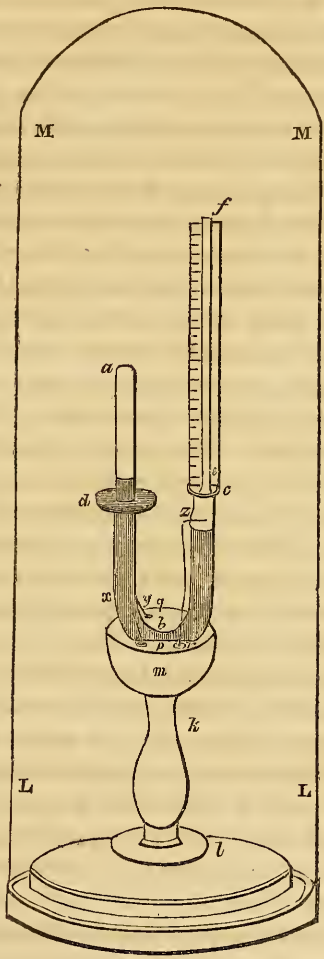
As instruments will no doubt be hereafter invented for measuring the phenomena of different classes of rays, it may prove convenient to designate the precise ray to which they apply. Perhaps the most simple mode is to affix the name of the ray itself. Under that nomenclature the instrument described in this paper would take the name of Indigo-tithonometer.

There is no difficulty in adapting this instrument to the determination of questions relating to absorption, reflection, and transmission. Thus I found that a piece of colorless French plate-glass transmitted 866 rays out of 1000.

*Description of the Instrument. First, of the glass part.*—The tithonometer consists of a glass tube bent into the form of a siphon, in which chlorine and hydrogen can be evolved from muriatic acid, containing chlorine in solution, by the agency of a voltaic current. It is represented by fig. 1, where *a b c* is a clear and thin tube four tenths of an inch external diameter, closed at the end *a*. At *d* a circular piece of metal, an inch in diameter, which may be called the stage, is fastened on the tube, the distance from *d* to *a* being 2·9 inches. At the point *x*, which is two inches and a quarter from *d*, two platina wires, *x* and *y*, are fused into the glass, and entering into the interior of the tube, are destined to furnish the supply of chlorine and hydrogen; from the stage *d* to the point *b*, the inner bend of the tube, is 2·6 inches, and from that point to the top of the siphon *c*, the distance is three inches and a half. Through the glass at *z*, three quarters of an inch from *c*, a third platina wire is passed; this wire terminates in the little mercury cup *r*, and *x* and *y* in the cups *p* and *q* respectively.

Things being thus arranged, the instrument is filled with its fluid prepared, as will presently be described; and as the legs *a b*, *b c*, are not parallel to each other, but include an angle of a few degrees, in the same way that Ure's eudiometer is arranged, there is no difficulty in transferring the liquid to the sealed leg. Enough is admitted to fill the sealed leg and the open one partially, leaving an empty space to the top of the tube at *c* of two and three quarter inches.

Fig. 1.

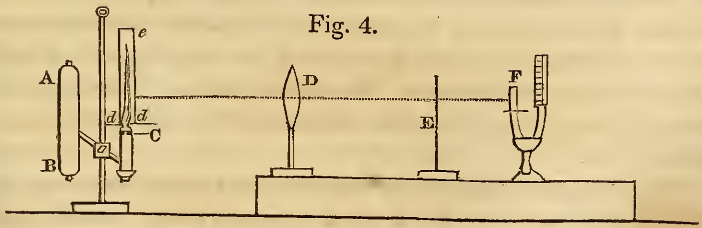



*The Tithonometer.*

Fig. 2.


Fig. 3.


Fig. 4.



A stout tube, six inches long and one tenth of an inch interior diameter, *ef*, is now fused on at *c*. Its lower end opens into the main siphon tube; its upper end is turned over at *f*, and is narrowed to a fine termination, so as barely to admit a pin, but is not closed. This serves to keep out dust, and in case of a little acid passing out, it does not flow over the scale and deface the divisions. At the back of this tube a scale is placed, divided into tenths of an inch, being numbered from above downwards. Fifty of these divisions are as many as will be required. Fig. 2 shows the termination of the narrow tube bent over the scale.

From a point one fourth of an inch above the stage *d*, downwards beyond the bend, and to within half an inch of the wire *z*, the whole tube is carefully painted with India ink so as to allow no light to pass; but all the space from a fourth of an inch above the stage *d* to the top of the tube *a*, is kept as clear and transparent as possible. This portion constitutes the sentient part of the instrument. A light metallic or pasteboard cap, A D, fig. 3, closed at the top and open at the bottom, three inches long and six tenths of an inch in diameter, blackened on its interior, may be dropped over this sentient tube; it being the office of the stage *d* to receive the lower end of the cap when it is dropped on the tube so as to shut out the light.

The foot of the instrument *k l* is of brass; it screws into the hemispherical block *m*, which may be made of hard wood or ivory; in this three holes, *p q r*, are made to serve as mercury cups; they should be deep and of small diameter, that the metal may not flow out when it inclines for the purpose of transferring. A brass cylindrical cover, L M, L M, may be put over the whole; when it is desirable to preserve it in total darkness, it should be blackened without.

*Secondly, of the fluid part.*—The fluid from which the mixture of chlorine and hydrogen is evolved, and by which it is confined, is yellow commercial muriatic acid, holding such a quantity of chlorine in solution that it exerts no action on the mixed gases as they are produced. From the mode of its preparation it always contains a certain quantity of chloride of platina, which gives it a deep golden color, a condition of considerable incidental importance.

When muriatic acid is decomposed by voltaic electricity, its chlorine is not evolved, but is taken up in very large quantity and held in solution; perhaps a bichloride of hydrogen results. If through such a solution hydrogen gas is passed in minute bubbles, it removes with it a certain proportion of the chlorine. From this therefore it is plain, that muriatic acid thus decomposed will not yield equal measures of chlorine and hydrogen, unless it has been previously impregnated with a certain volume of the former gas. Nor is it possible to obtain that degree of saturation by voltaic action, no matter how long the electrolysis is continued, if the hydrogen is allowed to pass through the liquid.

Practically, therefore, to obtain the tithonometric liquid, we are obliged to decompose commercial muriatic acid in a glass vessel, the positive electrodes being at the bottom of the vessel, and the negative at the surface of the liquid. Under these circumstances, the chlorine as it is disengaged is rapidly taken up, and the hydrogen being set free without its bubbles passing through the mass, the impregnation is carried to the point required.

Although this chlorinated muriatic acid cannot of course be kept in contact with the platina wires without acting on them, the action is much slower than might have been anticipated. I have examined the wires of tithonometers that had been in active use for four months, and could not perceive the platina sensibly destroyed. It is well however to put a piece of platina foil in the bottle in which the supply of chlorinated muriatic acid is kept; it communicates to it slowly the proper golden tint.

The liquid, being impregnated with chlorine in this manner until it exhales the odor of that gas, is to be transferred to the siphon *a b c* of the tithonometer, and its constitution finally adjusted as hereafter shown.

*Thirdly, of the Voltaic Battery.*—The battery, which will be found most applicable for these purposes, consists of two Grove's cells, the zinc surrounding the platina.

The following are the dimensions of the pairs which I use. The platina plate is half an inch wide and two inches long; it dips into a cylinder of porous biscuit-ware of the same dimensions, which contains nitric acid. Outside this porous vessel is the zinc, which is a cylinder one inch diameter, two inches long, and two tenths thick; it is amalgamated. The whole is contained in a cup two inches in diameter, and two deep, which also receives the dilute sulphuric acid.

The force of this battery is abundantly sufficient both for preparing the fluid originally, and for carrying on the tithonometric operations; it can decompose muriatic acid with rapidity, and will last with ordinary care for a long time.

Before passing to the mode of using the tithonometer, it is absolutely necessary to understand certain theoretical conditions of its equilibrium; to these in the next place I shall revert.

*Theoretical Conditions of Equilibrium.*—The tithonometer depends for its sensitiveness on the exact proportion of the mixed gases. If either one or the other is in excess, a great diminution of delicacy is the result. The comparison of its indications at different times depends on the certainty of evolving the gases in exact, or at all events, known proportions.

Whatever, therefore, affects the constitution of the sentient gases, alters at the same time their indications. Between those gases and the fluid which confines them certain relations subsist, the nature of which can be easily traced. Thus, if we had equal measures of chlorine and hydrogen, and the liquid not saturated with the former, it would be impossible to keep them without change, for by degrees a portion of chlorine would be dissolved, and an excess of hydrogen remain; or, if the liquid was overcharged with chlorine, an excess of that gas would accumulate in the sentient tube.

It is absolutely necessary, therefore, that there should be an equilibrium between the gaseous mixture and the confining fluid.

As has been said, when muriatic acid is decomposed by a voltaic current, all the chlorine is absorbed by the liquid and accumulates therein; the hydrogen bubbles however as they rise withdraw a certain proportion, and hence pure hydrogen passed up through the tithonometric fluid becomes exceedingly sensitive to the light.

There are certain circumstances connected with the constitution and use of the tithonometer which continually tend to change the nature of its liquid. The platina wires immersed in it by slow degrees give rise to a chloride of platina. It is true that this takes place very gradually, and by far the most formidable difficulty arises from a direct exhalation of chlorine from the narrow tube *ef*; for each time that the liquid descends, a volume of air is introduced, which receives a certain amount of chlorine, which with it is expelled the next time the battery raises the column to zero; and this, going on time after time, finally impresses a marked change on the liquid. I have tried to correct this in various ways, as by terminating the end *f* with a bulb; but this entails great inconvenience, as may be discovered by any one who will reflect on its operation.

When by the battery we have raised the index to its zero point, if the gas and liquid are not in equilibrio, that zero is liable to a slight change. If there be hydrogen in excess the zero will rise,—if chlorine, the zero will fall.

In making what will be termed "interrupted experiments," we must not too hastily determine the position of the index on the scale at the end of a trial. It is to be remembered that the cause of movement over the scale arises from a condensation of muriatic acid, but that condensation, though very rapid, is not instantaneous. Where time is valuable, and the instrument in perfect equilibrium, this condensation may be instantaneously effected, by simply inclining the instrument so that its liquid may pass down to the closed end *a*, but not so much as to allow gas to escape into the other leg; the inclination of the two legs to each other makes this a very easy manipulation, and the gas thus brought into contact with an extensive liquid surface yields up its muriatic acid in a moment.

*Directions for using the Tithonometer. Preliminary adjustment.*—Having transferred the liquid to the sealed end of the siphon, and placed the cap on the sentient extremity, the voltaic battery being prepared, the operator dips its polar wires into the cups *p q*, which are in connexion with the wires *x y*. Decomposition immediately takes place, chlorine and hydrogen rising through the liquid, and gradually depressing it, whilst of course a corresponding elevation takes place in the other limb; this operation is continued until the liquid has risen to the zero. It takes but a few seconds for this to be accomplished.

The polar wires having been disengaged, the tithonometer is removed opposite a window, care being taken that the light is not too strong. The cap is now lifted off the sentient extremity *a d*, and immediately the liquid descends. This exposure is allowed to continue, and the liquid suffered to rise as much as it will to the end *a*. And now, if the gases have been properly adjusted, an entire condensation will take place, the sentient tube *a d* filling completely. In practice this precision is not however obtained, and if a bubble as large as a peppercorn be left, the operator will be abundantly satisfied with the sensitiveness of his instrument. Commonly, at first, a large residue of hydrogen gas, occupying perhaps an inch or more, will be left. It is to be understood that even this large surplus will disappear in a few hours by absorbing chlorine. But this is not to be waited for; as soon as no further rise takes place in a minute or two, the siphon is to be inclined on one side, and the residue turned out into the open leg.

Now, recurring to what has been said on the equilibrium, it is plain that this excess of hydrogen arises from a want of chlorine in the tithonometric liquid. A proper quantity must therefore be furnished by proceeding as follows.

The sentient tube being filled with the liquid by inclination, connect the polar wires with *p q*, as before. These may be called *generating wires*. Allow the liquid to rise in *b c*, until the third platina wire *z*, which may be called the *adjusting wire*, is covered an eighth of an inch deep. Then remove the negative wire from the cup *p* into the cup *r*, and now the conditions for saturating the liquid are complete; hydrogen escaping away from the surface of the liquid at *z*, and chlorine continually accumulating and dissolving between *x* and *d*. This having been carried on for a short time, the gas in *a d* is to be turned out by inclination and the instrument recharged. That a proper quantity is evolved, is easily ascertained by allowing total condensation to take place, and observing that only a small bubble is left at *a*.

It will occasionally happen in this preliminary adjustment, that an excess of chlorine may arise from continuing the process too long. This is easily discovered by its greenish-yellow tint, and is to be removed by inclining the instrument and turning it out.

Thus adjusted, every thing is ready to obtain measures of any effect, there being two different methods by which this can be done,—1st, by continuous observation; 2d, by interrupted observation.

*Of the method of continuous observation.*—This is best described by resorting to an example. Suppose, therefore, it is required to verify table I, or, in other words, to prove that the effect on the tithonometer is proportional to its time of exposure.

Put on the cap of the sentient tube *a d*, connect the polar wires with *p q*, and raise the liquid to zero.

Place the tithonometer so that its sentient tube will receive the rays properly.

At a given instant, marked by a seconds watch, remove the cap A D, and the liquid at once begins to descend. At the end of the first minute, read off the division over which it is passing. Suppose it is 7. At the end of the second do the same, it should be 14; at the end of the third 21, &c. This may be done until the fiftieth division is reached, which is the terminus of the scale.

Recharge the tube by a momentary application of the polar wires: but it is convenient first to remove any excess of muriatic acid gas in the sentient tube by allowing it time for condensation; or if that be inadmissible, by inclining a little on one side, so as to give an extensive liquid contact.

*Of the method of interrupted observation.*—It frequently happens that observations cannot be had during a continuous descent, as when changes have to be made in parts of apparatus or arrangements. We have then to resort to interrupted observations.

This method requires that the gas and liquid should be well adjusted, so that no change can arise in volume when extensive contact is made by inclination.

The tithonometer being charged, place it in a proper position. At a given instant remove its cap, and the liquid descends. When the time marked by a seconds watch has elapsed, drop the cap on the sentient tube. The liquid simultaneously pauses in its descent, but does not entirely stop, for a little uncondensed muriatic acid still exists, which is slowly disappearing in the sentient tube. Now incline the instrument for a moment on one side, so that the liquid may run up to the cord *a*, but not so much as to let any gas escape. Restore it to its position and read off on the scale. It is then ready for a second trial.

The difference between continuous and interrupted observation is this, that in the latter we pause to wash out the muriatic acid, and though this is effected by the simplest of all possible methods, continuous observations are always to be preferred when they can be obtained.

I have extended this paper to so great a length, that many points on which remarks might have been made must be passed over. It is scarcely necessary to say that the sentient tube must be *uniformly* and perfectly clean. As a general rule also, the first observation may be cast aside, for reasons which I will give hereafter. Further, it is to be remarked, as it is an essential principle that during the different changes of volume of the gas its exposed surface must never vary in extent, the liquid is not to be suffered to rise above the blackened portion at *d*. If the measures of the different parts be such as have been here given, this cannot take place, for the liquid will fall below the fiftieth division before its other extremity rises above *d*.

The same original volume of gas in *a d* will last for a long time, as we keep replenishing it as often as the fiftieth division is reached.

The experimenter cannot help remarking, that on suddenly exposing the sentient tube to a bright light, *the liquid for an instant rises* on the scale, and on dropping the cap *in an instant falls.* This important phenomenon, which is strikingly seen under the action of an electric spark, I shall consider hereafter.

In conclusion, as to comparing the tithonometric indication at different times, if the gases have the same constitution, the observations will compare; and if they have not, the value can from time to time be ascertained by exposure to a lamp of constant intensity. To this method I commonly resort.

From the space occupied in this description the reader might be disposed to infer that the tithonometer is a very complicated instrument and difficult to use. He would form, however, an erroneous opinion. The preliminary adjustment can be made in five minutes, and with it an extensive series of measures obtained. These long details have been entered into that the theory of the instrument may be known, and optical artists construct it without difficulty. Though surprisingly sensitive to the action of the indigo ray, it is as manageable by a careful experimenter as a common differential thermometer.

University of New York, Sept. 26, 1843.

Art. II.—*Beaumontite and Lincolnite identical with Heulandite;* by Francis Alger, Member of the American Academy, of the Boston Society of Natural History, &c.

Read before the Boston Society of Natural History, Oct. 5, 1843, and published in their Journal.

There is a too prevalent disposition among mineralogists, as well as among the cultivators of other departments of natural science, to add something new to the catalogue of species. They make specific differences in many cases where by a fuller investigation, or a nicer comparison of the object with that which most nearly resembles it, an identity might be at once established between them, and the science not be burthened with so many new names. The truth of what I now say, has been shown by the recent examination of several minerals, accredited as new, which have been found by some of the German and Swedish chemists, to be varieties of other species, or in some cases, mere mechanical mixtures. A very frequent source of these mistakes, so far as mineralogy is concerned, is owing to a scrupulous regard not being paid to the chemical composition of the substance; this being the essential basis of mineralogy as a true science. Another cause may be traced to the different appearances, which the same mineral, from different localities, assumes in some of its external characters; appearing, perhaps, under some new modification of its primary form.

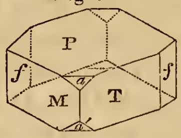
A remarkable instance of the latter, has recently been presented in the case of the mineral examined by M. Levy, and named Beaumontite.* This substance has long been familiar to our American mineralogists, as the associate of the Haydenite found near Baltimore. It has now become exceedingly valuable, principally through the investigations of M. Levy, who supposed it to be a new substance. It is a very beautiful mineral, and being extremely scarce, it will continue to be highly prized by mineralogists, both here and abroad, even if it should prove to be no new species, but only a rare modification of a well known one. I believe it has not been described in any of our late trea-

* M. Levy read his paper before the French Academy of Sciences, (L'Institut, 1839, No. 313, p. 455.) An abstract of his communication may be seen in the London and Edinburgh Phil. Mag. for Feb. 1840.

tises on mineralogy, nor am I aware that any notice has been taken of it in the American Journal of Science.

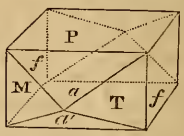
On comparing the crystals of this substance, with several of those of the Heulandite of Nova Scotia, which presented a modification rather uncommon, I was satisfied that they were both derived from the similar replacement of the acute lateral edges, and obtuse solid angles, of the same primary right oblique angled prism; the planes *f*, which in most instances are small, being now so extended as to reduce the length of the figure to nearly the same dimensions with its breadth; thus giving rise to what might, at first sight, appear to be a square prism, terminated by two obtuse four sided pyramids, resting upon the opposite lateral faces of the crystal, as I have endeavored to represent by the subjoined figure 2. The planes *a a′*, being carried to the extreme,

Fig. 1.




| | |
|---|---|
| P on M or T | 90° |
| M on T | 130 |
| M on *a* | 147 17′ |
| M on *f* | 114 20′ |
| P on *a* | 111 59′ |
| T on *a* | 148 |

Fig. 2.




so as to entirely obliterate the edge formed by the planes M and T, of the right oblique prism, fig. 1,—the pyramids thus resulting, are very beautiful in both minerals, particularly in the Beaumontite, and they present the same characteristic vitreous lustre, contrasted with the soft, pearly white reflection of the planes P, which we always observe in the crystals of this mineral from other localities. Both minerals, however, present shades of brown and yellow. On further comparing their hardness and pyrognostic characters, and failing also to obtain any other cleavage in the Baltimore specimens, than that well known in Heulandite, I could have but little doubt that M. Levy, (unless he had described some other very analogous mineral from this locality, which I have not seen,) had been misled by its unusual crystalline form, and, instead of making known a new species, had only given us the wrong characters of an old one. I am sure that he would not have been led into a mistake of this kind, had the crystals examined by him presented those *gradual changes* which have ultimately given rise to the figure supposed by him to be the primary right square prism of the Beaumontite, and which we so readily observe in the crystals from Nova Scotia.

This is the *only* respect in which the Heulandite from Nova Scotia, and M. Levy's mineral, differ from each other; and it is in reference to this single peculiarity in the approximation of the crystals of the Nova Scotia mineral to a right square prism, that it has hitherto commanded an especial interest among our mineralogists. I had never seen the decrement carried so completely out in the crystals from any other locality, until these beautiful specimens met my eye from Baltimore. The smaller replacements *b b′*, which are often seen in the crystals of this mineral from Faroe, I have never observed among the specimens from either of the localities here referred to, nor from any locality in the United States.*

To remove *all* doubt as to the identity of the two minerals, I requested Mr. J. E. Teschemacher to separate some of the best crystals from my Baltimore specimens, and subject them to measurement by the reflecting goniometer, as I well knew the public would have the fullest confidence in his use of that instrument. He has informed me that P on P gives 90°, M on T 130°, M on *a* 143° 17′, P on *a* 111° 58′, and adds that he has no doubt the mineral is Heulandite. The variation in the third measurement was owing to the imperfection of the surface. We have, therefore, every reason for believing that the specific nature of the Beaumontite of M. Levy, can no longer be maintained. It is proper to add, that the same name, in honor of a distinguished French naturalist, Elie de Beaumont, had already been applied to another mineral from Chessy in France, described and analyzed by my friend Dr. Charles T. Jackson.†

*Lincolnite.*—Prof. Hitchcock in his *Final Report on the Geological Survey of Massachusetts*, (p. 662,) has given the description of a mineral found in the vicinity of Deerfield, which he has named in honor of the late governor of that state. Unfortunately, it must share the same fate with Beaumontite, though it seems less entitled to the distinction of a new species; for in every respect but one, viz. its not being replaced on the obtuse solid angles by the planes *a*, as shown in fig. 1, it is impossible to discover any dissimilarity between this mineral and Heulandite; both exhibiting the same characters before the blowpipe, the same color, lustre, hardness, &c. The crystals of Lincolnite are very small,

* See fig. 2 in Phillips' Mineralogy, Allan's edition, p. 25.

† American Journal of Science, Vol. XXXVII, p. 398.

usually requiring a microscope in their examination, and they have their acute lateral edges replaced by very narrow planes *f*, corresponding in their measurement with Heulandite. But, according to Prof. Hitchcock, they differ from Heulandite in the proximate measurement of planes M on T about 10° (or 120° instead of 130°) as determined by the measurement of three different crystals with the common goniometer. It must be confessed, that the comparison of one set of characters alone, without some other corroborative evidence,—especially when, as in the present instance, the crystals are too small to admit of the accurate use of the common goniometer, does not authorize the making of a new species. Having received a few crystals of this mineral from Prof. Hitchcock, I also requested Mr. Teschemacher to measure them. The results showed the same agreement with the recorded measurements of W. Phillips, and has therefore established the true nature of this mineral beyond any doubt.

I would remark that crystals, precisely like those described by Prof. Hitchcock, have lately been found in gneiss on New York island; and apparently in the same rock associated with phosphate of lime at Suckasunny, New Jersey.* There can be no doubt, I think, that the radiated or fasciculated mineral accompanying these crystals is stilbite, and not a variety of Lincolnite or Heulandite, as Prof. Hitchcock supposes.

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## Art. III.—*Scraps in Natural History, (Quadrupeds;)* by Dr. John T. Plummer.

At the same time that Dr. Johnson attacked the "collector of shells and stones," and other objects of natural history, with his raillery and wit, he was compelled to acknowledge that there was "nothing more worthy of admiration to the philosophical eye, than the structure of animals, by which they are qualified to support life in the elements or climates to which they are appropriated." And, indeed, the most gifted minds have contemplated

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* Among some specimens which I have lately received from Copenhagen, through a distinguished friend of science, Compte de Vargas Bedemar, I observed precisely the same modified crystals with those of Lincolnite, but no near approach to the form of Beaumontite. These specimens are from Faroe, a region which the Count has personally examined.

the structure and the habits of animals with profit and satisfaction. Goldsmith has detailed the conduct of a spider; Addison watched the interesting motions of an ant, and could represent himself as highly entertained with his friend Roger de Coverly's hen and chickens; and omitting the citation of many more notable instances, the gentle Cowper could say of his hare—

> "I kept him for his humor's sake,
> For he would oft beguile
> My heart of thoughts that made it ache,
> And force me to a smile."

During some examinations into the natural history of this section of the country,* I have several times confined to my study some of the smaller animals captured in the fields and woods, for the purpose of witnessing their artifices and stratagems, the impulses of their nature. The results of some of my observations during the attempts at domestication of a few minor quadrupeds, are given below: whether what is there communicated is new to the naturalist, or being new is sufficiently interesting to be worthy of being presented to any of your readers, you have a better opportunity of knowing than I have.

*Sorex brevicaudatus*, or Short-tailed Shrew.—This nimble little creature, placed in an empty box, was observed to be very adroit in catching flies thrown in to him; but he never ran *across* the box to seize them, nor on any occasion did I ever discover that he left the sides and corners of it. Some cooked meat was given him the evening he was caught, and soon after eating it he died, but whether in consequence of being poisoned by the condiments upon the meat, or of the injuries inflicted while capturing him, I cannot tell.

In the spring of 1842 I caught another shrew, under a very rotten log, which it had converted into a perfect labyrinth; and in the largest excavation it had constructed a bed of dry leaves. Having nothing better at hand, I picked up a vertebra of a horse, and fastening the little animal in the spinal canal, I brought him safely home. Turning him out into a glass vessel five inches deep, with perpendicular sides, I covered it with a book, upon which I laid the vertebra, and supposed my little captive was perfectly secure. In a short time after leaving it, however, he

* Richmond, Wayne County, Indiana.

succeeded in pushing the covering to one side, and escaped. The book and the bone together weighed on trial upwards of a pound; and, considering the mechanical disadvantages of a smooth, glassy surface, and of the rampant position of the shrew while effecting his liberation, this achievement indicated a degree of strength that surpassed my expectations. Having retaken the little prisoner, I confined him to a box, well provided with masses of rotten wood, paper and other materials. As soon as I turned him into his new habitation, he hastened to the bottom of the box, and commenced making a new, and to him more satisfactory, arrangement of the smaller pieces of wood and other fragments scattered below; his object appearing more particularly to be, to block up the larger openings around him. This task he accomplished with much skill, first dragging and fitting the larger pieces to the apertures, and then filling up the interstices with fragments of smaller size; after this he crumbled with his teeth the projecting and more accessible parts, and the powder falling into the remaining spaces completed a hiding place. Having thus barricaded his retreat, and otherwise strengthened his frontier, he spent some time in reconnoitering the more central parts, and appeared to run with great delight, in the most lively manner, through all the windings and irregularities of his new abode, peeping out in rapid succession, and snuffing the air, at the various holes he had left for egress and ingress. It was quite entertaining, during these incessant motions, to listen to his seemingly gleeful rushes through his tortuous apartments, and to watch with pleasing uncertainty the various orifices, to see at which he would next thrust out his nose. After having thus familiarized himself to the different routes by which he might retreat in case of danger, he began to snatch and jerk into the interior such portions of paper and rags as were nearest at hand; these I afterward found he cut into small pieces, and formed into a neat little bed.

These preparatory employments being over, he began to protrude his body with great caution from a hole which appeared to be a favorite outlet, but started back with the utmost precipitation upon the slightest noise, and in a moment after he would slily peep out at some other opening. At length, having ventured entirely out, he seized a large earth-worm which I had thrown into the box, the very instant it was perceived, and in spite of its violent contortions the shrew ate it with avidity, sometimes confining the motions of the worm by pressing it down with its fore feet. By proper attention, he became in a few days unconcerned at my presence, and when I threw in additional blocks of wood, &c. he came out into full view to adjust them, dragging large pieces a considerable distance with apparent ease. For days and weeks he received corn, insects and worms from my hand, but always with that sudden snatch that characterized it at the beginning. If I held fast to the worm, he would tug at the other end, and jerk at it, till I let go, or the worm was lacerated by his efforts. At such times I have often raised him into the air by means of the worm. When a number of worms were thrown in together, I never knew him to take one from the mass, unless he could seize an end which projected from the heap. Flesh of all kinds, fresh fish, coleopterous as well as other insects, slugs, millepeds, corn, oats, and every kind of grain which was tried, appeared to be acceptable food. The corcle of the grains of maize was always eaten out, as it is by rats and mice.

When this little quadruped was satiated with food, it never ceased to store away the surplus provisions it might be supplied with, till its granaries and other repositories were filled. I say granaries and other repositories, for on carefully opening into his various recesses, I ascertained that he had separate storehouses: one for corn, which was neatly packed away, grain upon grain, flatwise; another for his oats; and a third for worms and insects. One day I discovered that he had brought out a number of grains of corn which had sprouted; and the granary having been dampened by water, accidentally spilled in the box, I afterward found the shrew had garbled his grain and conveyed the sound corn to a drier repository. When water was put into the box, he wet his tongue two or three times and went away; but when worms were dropped into the cup, he returned, waded about in the water, snatched up his victim, maimed it, stored it away, and returned repeatedly for more, till all were secured.

By gentle attentions, I had by this time so far subdued his timidity, and instructed him in my language, that by night or by day, and at all times, whether in his hiding places in the box, or running at large in the room, or safely ensconced in secret and inaccessible fissures, he was ready to come at my call, and receive from my hand his accustomed meal. It was curious to observe, that unless he was called into the area of the room, he never approached his box or any other point, except by a circuitous route against the wall. To his box he would always retire to repose during the hot noons of summer, and it was evident that at this period he did not like to be disturbed; nevertheless at the well known call he always came, but never at these seasons with his usual alacrity. The buzz of a fly would usually attract him to the surface; but in his dozing hours, if he heard at all, he always heard it with unconcern.

A full grown and living mouse being one day put into his box, very naturally secreted itself among the pieces of wood; but it had scarcely had time to reach the chambers below, before it suddenly appeared at the surface again, fiercely pursued by the shrew: down it went, and up it came, around and through all the meanderings of the box it flew, with erect ears and wildly staring eyes, and every token of astonishment and fear, the eager shrew being at its heels, till by fair chasing it was overtaken by the proper tenant of the box. I think I never witnessed more lively demonstrations of terror, than were exhibited by this poor mouse during the pursuit. While in the grasp of the shrew it made no resistance and uttered no cry, and so resolute and bloodthirsty did the shrew appear, that no noises or jarrings of the box frightened it; and it was not until I repeatedly punched it with a rule, that I induced it to relinquish its hold. But the mouse was dead; its feet, tail, snout, neck and cheeks being much lacerated. Another mouse met with the same fate, and nearly in the same manner.

While thus experimenting with this shrew, a person stepping into the office, said he had brought me a novel kind of mouse; but on examining his pocket, he found it had escaped. He left me, spent the greater part of the day in engagements about town, and in the evening returned to tell me that the "mouse," which proved to be a shrew, was under the back of his coat. Thither the little creature had crept, as to a place more congenial to its feelings of security. It was younger than the one already in my possession. Carefully securing it, I put it into the box with the other shrew: it went below, and remained there much of the time, but was frequently chased by the older one, without being often overtaken. Sometimes in their wanderings about the box, they would unexpectedly meet upon the surface, when a vigorous combat would ensue. Once the younger one perceived the other close in its rear; it sent forth a shrill chirp, wheeled about suddenly and came to close quarters with the rightful resident of the box, to whose superior strength, however, it ultimately fell a prey. The dead body was dragged below and deposited in the soft bed of the shrew, which now, for what reason I do not know, began to construct a new nest.

The voice of this animal in retreating to its harboring places, is almost precisely that of the ground-squirrel, being a rapidly uttered *chip-chip-chip.* Its propensity to gnaw is considerable, but perhaps not so great as that of the mouse. Repeated experiments have convinced me, that (unless peculiar odors are an exception) its sight and smell cannot extend beyond the distance of half an inch; but its sense of hearing is extremely acute.

Dr. Godman says of shrews: "These animals rarely come out in the day-time, and are so small as to require very close attention to observe their modes of living." My captive ventured out of his own accord, equally in the day as in the night; and I never experienced any difficulty in observing its "modes of living." The same author states, that though insects are their principal subsistence, they seem no less fond of "putrid flesh, and filth of various sorts." Such a character by no means befits the short-tailed shrew; for the one in my possession was as cleanly, tidy, and choice in the quality of his food, as any little quadruped I ever knew; always bringing out the putrid worms and decaying grains from his cell, and always preferring the living to the dead: his habitation was as clean as possible, egestion being performed in a concealed corner. I can also say on behalf of my prisoner, that during the two spring months of his dependence upon me for subsistence, I never perceived any annoying smell, much less that disgusting odor with which, like the polecat, shrews are said to stand *charged.*

Could this little animal be domesticated, so as to be serviceable in exterminating mice from our dwellings?

*Mustela pusilla,* or Weasel.—I purchased one of half a dozen weasels which were found near town in the same nest, and put it into a box; in a short time it coiled itself up and slept. Not being easily roused from its slumbers, I have repeatedly been able to "catch a weasel asleep." It frequently cried, but apparently only when hungry, and it allowed itself to be handled with freedom. Shortly after, perhaps a week, one of the others was purchased and placed in the same room, about which they now ran in perfect amity, gamboling and playing together like kittens. I fed them with meat, Unios and Helices, which they ate either raw or cooked. They would often, as I entered the apartment, run toward me, and frisk about my feet; and always obeyed my call. Living mice were seized by them, and hugged with all their feet and legs, while with the mouth they bit fiercely all along the spine in rapid succession, and then they attacked the head and other parts of the body, the whole process being the work of a moment.

When they were about a month old, I enfeebled a large and veteran brown rat by almost suffocating him under water, and placed him in their view; they immediately scampered off in evident affright. Maiming the rat by sundry blows upon his head, he was fastened in an empty box with the weasels; these, dashing furiously but vainly against the glass lid to effect their escape, at last huddled together in a remote corner, while the rat, with seeming gravity and unconcern, sat motionless at the other side of the box, the weasels still manifesting great trepidation. I then shook them together, when the rat bit one of the weasels on the back so as totally to paralyze its hind legs; and the other weasel, escaping immediately from the box without a wound, was thrown into violent but transient convulsions. For these spasmodic attacks, renewed at short intervals for perhaps twenty minutes, I can assign no other cause than extreme terror. The bitten weasel refused to eat, became rapidly emaciated, and soon died. The other, not feeling himself safe even in the wide room, with such a mortal enemy, jumped out of a second story window, and ran away.

*Rats and Mice.*—A correspondent of the Penny Magazine, Part XI, attempts to prove that mice have no instinctive fear of the cat, by the fact, that having caught a mouse in a secluded part of one of the coal mines of England,—a mine into which a cat had never been introduced,—he placed it in a glass lantern, and after several days admitted a cat into the room; the cat rushed toward the imprisoned mouse with "dire intent," but the mouse, perfectly indifferent to its fury, proceeded with its ablutions.

Now this imperturbable disposition is daily manifested in the rats and mice caught about our habitations, where doubtless many of our victims, peering securely at puss, have seen her watching the mouse-hole from which they have put out their heads, with a face of saucy gravity that seemed to ask her, whether she was "looking for any one in particular." Often have I seen such, in open wire traps and in glass vessels, eat corn and wash themselves, with the most perfect composure, in despite of the presence of dog, cat or man.

By this statement I do not of course wish to imply that there is a natural dread of the cat inherent in the mouse, but only that the experiment with the mouse from the coal pit is inconclusive. A sense of security from feline attacks, while thus shut up, *may* be sufficient to allay any innate fears of danger from that quarter. It appears, at least, that there was nothing peculiar in the conduct of the mouse from the mine.

*The Horse.*—Some years ago the citizens of a neighboring town (Centerville) were often amused by the conduct of a horse, when, with others, he was turned into the barn-yard to be watered. One day, approaching the trough and finding it empty, he seized the pump handle, to the surprise of the witnesses, between his teeth, and pumped water sufficient for himself and the other horses. Having thus begun, he was allowed, when so inclined, to wait upon himself and companions afterward. But it was observed, that he always drove the other horses away until he quenched his own thirst, after which he pumped for the rest.

*Cow and Pig.*—Riding by some cattle which were resting at the roadside, I observed a cow lying down, and a stout pig with his snout upon her bag. Stopping my horse to determine whether the conjecture thus excited in my mind was correct, I found the pig was actually engaged in drawing nourishment from the cow's teats. The cow appeared to be perfectly at ease, and the pig to be master of the sugescent art, though exercised under this novel relationship.

*Dogs.*—My father had two dogs. A bone being thrown out, the larger one seized it, and while gnawing it the small dog sat down near him and contemplated the scene with a wistful countenance, not daring to contend for the prize. He soon rose, walked around the corner of the house, returned, resumed his former position; and shortly after again retired around the house. Repeating this maneuver the third time without success, he seated himself as before, then suddenly raised his head, looked down the lane with an air of great excitement, and starting up, ran full speed toward the pretended object of his attack. The larger dog, effectually deceived by this stratagem, left the bone, quickly followed, outstripped the other and soon reached the gate, but only to find that he had nothing to bark at. The little dog in the mean while had slily hastened back, and carried off the bone. Under the head of "Genius among Animals," Spurzheim relates two similar instances of canine sagacity: one little dog, by such an artifice, was accustomed to "secure his portion;" and a pointer, by the same means, obtained a comfortable place near the fire from which he was excluded by other dogs in the family.

*Squirrels: larvæ of Estrus in them.*—Westwood states, in his "Modern Classification of Insects," that "each species of Estrus is parasitic upon a peculiar species of mammiferous herbivorous animal;" and that "the ox, horse, ass, reindeer, stag, antelope, camel, sheep, hare and rhinoceros, [in a note, he adds the badger and monkey,] are the only quadrupeds hitherto observed to be subject to the attacks of these insects." To this catalogue must be added the squirrel; for I have in my possession an estrous larva about three fourths of an inch long, two or three lines broad, and perfectly black, which was taken from the back of a *Sciurus leucotis*, (Bachman,) or northern gray squirrel.

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## *Quadrupeds about Richmond, Wayne County, Indiana.*

"*Local lists* are still wanting, to enable naturalists to trace their geographical limits with precision."—*Richardson.*

This remark of Dr. Richardson, though made in reference to the feathered tribes, is perhaps equally applicable to other objects of natural history. Under this impression, I offer you the following catalogue of mammals found in this vicinity before and since its settlement by white men.

Preliminary statements respecting the physical character, and the progress of civilized population, are not, I presume, inappropriate to zoological catalogues. For it is well known that some animals follow the path of civilization, while others flee before it; some seek the streams, and some the hills; others select the plains, the open forests, or the tangled wood. There is also a certain relation between the kind of trees and the wild tenants of the forest. Whether these relations between animals and their residence are fixed and universal, so that knowing the one we shall be able to infer the other, is an interesting question yet to be determined.

White emigrants established themselves here as early as 1805. The county covers an area of about four hundred square miles; the land is level, but has various deep drains, is rich, well wooded, without underbrush; copiously watered, but not by large streams. The increase of population has been such, that the number of inhabitants in 1840 was about twenty three thousand, and Richmond, which was laid out in 1816, contains three thousand of these. The latitude of the town is 39° 51′ N. Fagus sylvatica, Acer saccharinum, various species of Quercus, of Carya, and of Juglans, and Liriodendron tulipifera, are the prevailing kinds of timber.

As this section of country is comparatively new, it is presumable that a change will take place in its zoological character; such a change has indeed already commenced, and its progress up to the present time, will be indicated in the notes to the catalogue.

I cannot venture to say, that the subjoined enumeration embraces all the mammalia of this county; but it is as nearly complete as persevering research for several years has been able to make it. Besides my own observations, I have availed myself of the opportunity of gaining information from the first white settlers of this district; an advantage which will soon be beyond the reach of the future naturalist. If I have omitted any animals now existing here, I can only say, I have had no assistance in detecting them; and if the catalogue is not lengthened to the utmost, I hope it will be found accurate as far as it extends.

## Carnivora.

### *Vespertilionidæ.*

1. Vespertilio Noveboracensis, Linn., New York or Red Bat.
2. V. pruinosus, Say, Hoary Bat.
3. V. subulatus, Say, Subulate-eared Bat.

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1, 2, 3. *Vespertiliones.* These are the only species of bat in my collection, and I believe are all that have been found here. *V. subulatus* appears at present to be the most common. A *V. Noveboracensis* and a *V. pruinosus*, more than four inches long, the former a male and the latter a female, were captured in the fall while flying together in the same room.

*Soricidæ.*

4. Sorex brevicaudis, Say, Short-tailed Shrew.

*Talpidæ.*

5. Scalops Canadensis, Cuv., Shrew Mole.

*Ursidæ.*

6. Ursus Americanus, Pallas, Black Bear.
7. Procyon lotor, Cuv., Raccoon.

*Canidæ.*

8. Canis familiaris, Linn., Dog.
9. C. lupus, Linn., Wolf.
10. C. cinereo-argentatus, Gmel., Grey Fox.

*Felidæ.*

11. Felis maniculata, Linn., Domestic Cat.
12. Lyncus rufus, Harlan, Wild Cat.

*Mustelidæ.*

13. Mustela pennanti, Erxl., Fisher.
14. M. pusilla, Dekay, Weasel.
15. Lutra Canadensis, Rich., Otter.
16. Putorius vison, Emmons, Mink.
17. Mephitis Americana, Desm., Skunk.

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4. *S. brevicaudis.* This shrew, which is quite common, is the only species which I have been able to detect.

5. *Shrew moles* are very numerous. Do they seek mellow soils?

6. The *black bear* was killed in the immediate neighborhood of Richmond as late as the year 1824, when some cubs were also taken within a mile of town.

7. *Raccoons* are common, and are often hunted for amusement.

9. *Wolves* were numerous for several years after the settlement of the country, but none have been seen for fifteen years past.

10. The *gray fox* is still found in the more wooded parts of the county. During earthquakes felt here in 1811 and 1812, it is said great numbers of foxes were started out of their retreats.

12. This *wild cat*, once common, has seldom been seen since 1823.

13. I cannot find that the *fisher* has been seen since 1820; at an earlier period it was not uncommon.

14. This small *weasel* is frequently brought into town to be sold, being generally taken while young.

15. *Otters* still linger in the county, but they are quite rare.

16. *Minks* are quite an annoyance to our husbandmen.

17. This disgusting animal, though recently killed here, is not common.

*Didelphidæ.*

18. Didelphis Virginiana, Opossum.

RODENTIA.

*Castoridæ.*

19. Castor fiber, Harlan, Beaver.
20. Fiber zibethicus, Desm., Muskrat.

*Leporidæ.*

21. Lepus Americanus, Lab., Hare.

*Muridæ.*

22. Arvicola xanthognata, Leach, Meadow Mouse.
23. A. riparius, Ord. in Godman, Marsh Mouse.

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18. The *opossum* is rare; his favorite food, the persimmon, is not found in the county.

19. Beaver dams are still found in a dilapidated condition along our streams, but the animal has not been seen by any of the white settlers.

20. *Muskrats* are not numerous, but it is thought they have increased in number since the settlement of the county in 1805.

21. The *hare* is common, and does considerable mischief to our nurseries and young orchards, by gnawing the bark off the trees during winter.

22. One of these little animals was found in its large nest lined with rabbit's fur, on the outside of the wall of a well thirty feet below the surface of the earth!

23. The animal which I have designated *Arvicola riparius*, may be a different species, perhaps a new one. It varies from the description given by Godman as follows: the tail is not "nearly the length of the body," and is covered with short brown hairs, except a few elongated ones at the tip, and these converge to a point; on the closest inspection, but *four* teats were found, and these were situated between the hind legs, and were conspicuously large. *Three* young ones only were obtained with the female which was brought to me. Its toes are fringed with hairs which project over the nails. In other respects it accurately accords with the characters of *A. riparius*. My specimens are about four inches long, from the tip of the snout to the end of the tail; the tail is eight tenths of an inch long. Its minute eyes, short tail, and concealed ears, give this little animal a striking resemblance to the shrew. It is sometimes found in the woods, and sometimes under stacks of corn left in the field. Two specimens, which I attempted to keep in a box at different times, gnawed wood like a mouse, ate corn, refused meat and worms, were rather sluggish in their movements, and in a few days, without any apparent cause, they died. They had received no injury in capturing them. One was a male, the other a female.

Godman says the upper molar teeth of the rat (Mus) "are very remarkable for being inclined from before backwards." On looking over a considerable number of skulls in my cabinet, I find the molar teeth of the above animal, and of the *Lepus Americanus*, &c. quite as conspicuously inclined backwards as those of the rat.

24. Mus musculus, Linn., Domestic Mouse.
25. M. agrarius, Gmel., Rustic Mouse.
26. M. rattus, Linn., Black Rat.
27. M. decumanus, Pal., Brown Rat.
28. Arctomys monax, Gmel., Wood Chuk, (Webster.)
29. Sciurus Carolinensis, Gmel. (*leucotis*, Bach.,) Grey Squirrel.
30. S. niger, Linn., Black Squirrel.
31. S. striatus, Klein, Ground Squirrel.
32. Pteromys volucella, Linn., Flying Squirrel.
33. Gerbillus Canadensis, Desm., Jumping Mouse.

### *Hystricidæ.*

34. Hystrix dorsata, Linn., Porcupine.

## Pachydermata.

### *Equidæ.*

35. Equus cabellus, Linn., Horse.
36. E. asinus, Linn., Ass.

### *Suidæ.*

37. Sus scrofa, Linn., Hog.

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24. This little animal still maintains its possession of our dwellings, but its numbers have evidently been diminished since the introduction of the brown rat.

25. The *rustic mouse* is common.

26. In a few years after the incursion of the brown or Norway rat, the *black rat* became totally unknown.

27. This universally despised creature made its appearance here in 1835. *White* varieties of this rat have several times been brought to me as a new species; they have always proved to be *albinos.*

28. The *wood-chuk,* so far as I can learn, is seldom met with.

29. The *grey squirrels,* for twelve or fifteen years after the settlement of the country, were exceedingly numerous and injurious to the corn-fields. At present, their numbers are not objectionable, barely furnishing sufficient game for our sportsmen. I have seen several *white* squirrels (albinos) of this species.

30, 31, 32. Of these, the *black squirrel* is the rarest; the pretty *ground squirrel* often greets the eye, as it skims along the prostrate tree; and the *flying squirrel* is frequently captured in cutting down hollow trees; five or six of these animals generally being found together.

33. This year (1843) I surprised one of these little creatures in a thinly-grown wheat field. By four or five leaps it reached its retreat in the ground, where it escaped. It must be comparatively rare, as I have not yet met with any of our farmers who are acquainted with it.

34. Several *porcupines* have been killed in the suburbs of Richmond within a few years past. I have a fine specimen in my collection, captured near this town.

RUMINANTIA.

*Bovidæ, &c.*

38. Bos taurus, Linn., Ox.
39. B. Americanus, Gmel., Bison.
40. Ovis aries, Linn., Sheep.
41. Capra hircus, Linn., Goat.

*Cervidæ.*

42. Cervus Virginianus, Gmel., Deer.
43. C. Canadensis, Briss., Elk.

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ART. IV.—*Analysis of Wines from Palestine, Syria, and Asia Minor, and of specimens of American Cider;* by Prof. EDWARD HITCHCOCK, LL. D. of Amherst College.

IT is well known that in the discussions which have arisen in this country and England on the subject of temperance, much has been said respecting the character of the wines described in the Bible and other ancient writings. By some it was maintained, "that few if any of the wines of antiquity were alcoholic;" "that the strongest grape-wines of the ancients had in them a less quantity of alcohol than our common table beer;" "that of one hundred and ninety five kinds of wine used by the Romans in Pliny's time, only one was alcoholic;" "that amongst the Jews in Judea, there was a real difficulty, from chemical and natural causes, in the making and preserving any wines except the unfermented;" "that the wines of Palestine were not alcoholic," &c. (*Anti-Bacchus.*) A vast amount of curious learning

39. The evidence I have of the former existence of the *bison* in this county is, that several skulls, with the nucleus of the horns attached, have been ploughed up in our alluvial fields. They have all been found in an advanced state of decomposition.

42. The *deer* is seldom seen in this county at present, except some that are domesticated. It was formerly common game.

43. An *elk* was killed not far from Richmond about the year 1811. The horns of the elk have been found in our woods in various states of decay. One in my possession, originally between five and six feet long, was obtained within three miles of Richmond, and was sufficiently sound to induce the former owner to saw off the ends of the branches for knife-handles. Elkhorn, a water-course near Richmond, received its name from the number of these horns found upon its banks.

was put in requisition in the discussion of this subject. But it has seemed to me that a few analyses of wines from some of the most famous localities of western Asia, whence the wines of Scripture were obtained, would do much more towards settling the question as to their alcoholic character, than the most ingenious philological criticisms. And I confess I was surprised to find that no such analysis had been made. I wrote, therefore, to my friend, Rev. Henry J. Van Lennep, American missionary at Smyrna, requesting him to send me specimens of the common wines of Palestine, Syria, and Asia Minor. As Mr. Van Lennep was a native of Smyrna, I thought he would be better acquainted with the proper localities than a foreigner, and be more sure of obtaining specimens in an unenforced and unadulterated state; while the fact that he was educated in this country, would make him fully acquainted with the precise object I had in view. I was particular to request him to send no specimen but the pure juice of the grape, to which no ardent spirit had been added. To my request he kindly attended, though with no small trouble. In a letter dated at Smyrna, Sept. 23, 1842, he says: "I have been a great while in fulfilling your commission for specimens of wine from the Levant. I have met with a good deal of difficulty in obtaining specimens from Syria and Palestine, or rather in getting them transported from thence. For what with quarantine regulations, delays of vessels, &c. it is now more than a year, I think, since I wrote to some of the missionary brethren at Beyroot and Jerusalem on the subject. I now forward to Boston, to your address, a box containing the following: one bottle of wine from Mount Lebanon, one year old, and another from the same place, six years old; two bottles from Hebron, age unknown; one bottle from Corfu, age unknown; one bottle from Syria, place and age unknown; one bottle from Cyprus, not old; one bottle from Samos, not old; one bottle from Rhodes, one year old; one bottle from Smyrna, new, that is, about a year old. I hope the custom-house officers will not open the box, and shall therefore write the contents on the outside. But with all the precautions I have taken, I should not be surprised should they all, or many of them, reach you soured. Then, instead of your laboratory, they will take their place in your store-room, and whenever you have salad on your table, you will please pour on the vinegar to my health—a sour health to be sure!"

Fortunately, this anticipation of Mr. Van Lennep was not realized, except that one of the bottles from Hebron contained considerable acetic acid, probably because in passing through so many custom-houses it had been tested till nearly half of it was gone; yet even this, as we shall see, contained no small share of alcohol. All the other bottles, on breaking their seals, were found in a healthy state. And I may add, that in none of them could I discover any carbonic acid; so that probably the process of fermentation had been completed.

The mode of analysis was essentially that of Mr. Brande. The specific gravities were determined by ascertaining the weight of a tube full of the liquor and comparing it with the same tube full of distilled water, in all cases at a temperature of 60° Fah. The tube which I employed, held 736·4 grains of distilled water, and was suspended from one of the arms of Chemin's delicate balances. The weight of the tube and liquid was indeed rather too great for a balance of this description, and I do not think I could be sure of the weight nearer than the one tenth of a grain, although with small quantities the one hundredth of a grain was perceptible. After weighing the tube full of wine, in order to obtain its specific gravity, it was distilled nearly to dryness, from a small retort into a receiver surrounded by snow, and afterwards, to make up for the deficiency, another small portion of the wine was distilled also nearly to dryness. Enough was thus obtained of the distilled liquor to fill the tube, which was then weighed and the specific gravity thence deduced. In deducing from thence the per centum of alcohol, I used the new tables of Tralles, founded upon the principles of those by Gilpin, and given by Dr. Ure in his Dictionary of the Arts, Manufactures and Mines. These tables assume that water at the temperature of 60°, has a specific gravity of 0·9991; and they give the per centum of anhydrous alcohol by measure. Hence they show a smaller amount of alcohol than those of Gilpin, used by Professors Brande and Beck, whose standard is alcohol of the specific gravity of 0·825. But as Gilpin's tables have been so commonly used, I have added a column of the amount of alcohol by measure, as obtained by those tables in Brande's Chemistry. The tables of Lowitz of St. Petersburgh are also preferred by some. He assumes as his standard, alcohol of the specific gravity ·796 at 60° Fah., and gives the per centum by weight. I have given a column deduced from his tables, also, as contained in the second supplement to the seventh London edition of Turner's Chemistry, by Prof. Gregory. From the specific gravity of the wine before and after distillation, I have deduced the amount of solid matter, and given the per centum by weight. Finally, I have added a column of the per centum by measure of brandy, on the supposition that brandy contains 49·44 per cent. of pure alcohol.

As others like myself, who may desire to analyze fermented liquors, may not be able to procure Gay Lussac's apparatus for that purpose, I will observe, that I used two methods of connecting the retort and receiver, which I consider much better than to lute them together. One was, to make the junction by a strong India rubber tube, tied firmly to both vessels by a waxed thread. The other, and still better method, was, to find a receiver whose neck would just admit the neck of the retort with a piece of firm paper wound carefully around it and slightly pasted to it. By giving the retort a screwing motion, it was easily made to fit into the receiver so firmly that there was no danger of leakage.

*Results of the Analysis of Wines from Palestine, Syria and the Levant.*

| LOCALITY. | | Specific gravity before distillation. | Specific gravity after distillation. | Per cent. of solid matter. | Per cent. of alcohol by measure by the tables of Tralles, sp. gr. of standard alcohol at 60° Fahr., 0·7946. | | Per cent. by the tables of Gilpin, sp. gr. of standard alcohol 0·825. | Per cent. by the tables of Lowitz by weight, sp. gr. of stand. alcoh. 0·796. | Per cent. of brandy, containing 49·44 per cent. of alcohol. |
|---|---|---|---|---|---|---|---|---|---|
| No. 1. Hebron, soured, age unknown, | | 1·0097 | 0·9809 | 2·85 | 14·3 | | 15·52 | 14·2 | 28·90 |
| No. 2. Hebron, age unknown, | 1st trial, | 1·0083 | 0·9770 | 3·10 | 18·1 | 17.50 | 19·50 | 17·1 | 35·40 |
| | 2d trial, | 1·0086 | 0·9782 | 3·01 | 16·9 | | 18·32 | 15·9 | |
| No. 3. Mount Lebanon, 1 year old, | 1st trial, | 1·0121 | 0·9812 | 3 05 | 14·0 | 14.15 | 15·19 | 13·8 | 28·62 |
| | 2d trial, | | 0·9809 | | 14·3 | | 15·40 | 14·1 | |
| No. 4. Mount Lebanon, 6 years old, | 1st trial, | 1·0892 | 0·9852 | 9·55 | 10·4 | 10·95 | 11·26 | 11·9 | 22·03 |
| | 2d trial, | 1·0880 | 0·9839 | 9·57 | 11·5 | | 12·50 | 12·2 | |
| No. 5. Syria, (Port wine,) place and age unknown, | 1st trial, | 1 0051 | 0·9808 | 2·42 | 14·4 | 14·70 | 15·48 | 14·3 | 29·57 |
| | 2d trial, | | 0·9802 | | 15 0 | | 16·21 | 14·9 | |
| No. 6. Cyprus, not old, | 1st trial, | 1·0220 | 0·9779 | 4·31 | 17·2 | 17·05 | 18 63 | 16·2 | 35·49 |
| | 2d trial, | 1·0254 | 0·9782 | 4·60 | 16·9 | | 18·31 | 15·9 | |
| No. 7. Rhodes, one year old, | 1st trial, | 0·9920 | 0·9772 | 1·49 | 17·9 | 17·75 | 19·25 | 16·9 | 35·90 |
| | 2d trial, | 0·9909 | 0·9775 | 1·35 | 17·6 | | 19·00 | 16·6 | |
| No. 8. Corfu, age unknown, | 1st trial, | 0·9930 | 0·9790 | 1·41 | 16·1 | 15·75 | 17·26 | 15·6 | 31·86 |
| | 2d trial, | | 0·9798 | | 15·4 | | 16·61 | 15·2 | |
| No. 9. Samos, not old, | 1st trial, | 1·0205 | 0·9812 | 3·85 | 14·0 | 14·35 | 15·19 | 13·9 | 29·03 |
| | 2d trial, | 1·0226 | 0·9805 | 4·11 | 14·7 | | 15·91 | 14·6 | |
| No. 10. Smyrna, rather new, | 1st trial, | 1·0162 | 0·9826 | 3·31 | 12·7 | 13·00 | 13·78 | 13·3 | 26·30 |
| | 2d trial, | | 0·9820 | | 13·3 | | 14·33 | 13·1 | |

I was surprised to find so much alcohol as the above table exhibits in No. 1, which would pass for tolerably good vinegar.

No. 2, from the same locality, shows us probably how much alcohol it contained before the acetic fermentation commenced. These specimens were from grapes grown probably not far from the "valley of Eschol," whence the famous cluster was borne away by the Jewish spies in the time of Moses: for that valley must have been in the southeasterly part of Palestine. No 2 has the taste of strong Madeira wine. Nos. 3 and 4 are from Mount Lebanon, one of the most famous localities of the wines of Scripture. No. 3 is astringent and somewhat sweet, yet it appears to be fully wrought. No. 4 has a similar taste, but it is quite thick, as its high specific gravity shows; and I strongly suspect that the grape juice was partially boiled down before it was allowed to ferment, as we know was formerly practiced, and is still done on Mount Lebanon according to Mr. Buckingham. It has the appearance of the other wines after they have been heated to the boiling point in the retort; that is, a redder color than is natural. No. 5 is perfect Port wine in color, taste, and the amount of sediment deposited in the bottle. No. 6 is from Cyprus, which is one of the most famous localities of the ancient Greek wines. It is sweet and astringent, but not thick, and has no appearance of having been boiled before fermentation, as Mr. Buckingham says is usually done on that island. It will be seen that it is a very strong wine. The age of these wines mentioned in the table, are their ages when obtained by Mr. Van Lennep. A year more at least should be added, except perhaps in one or two cases, as having elapsed before they were analyzed. No. 7, from Rhodes, is a very clear strong wine, the strongest which I analyzed, and slightly astringent; resembling some varieties of Madeira. No. 8, from Corfu, whose age is unknown, considerably resembles it in appearance and taste, and, as the analysis shows, in alcoholic power. No. 9, from Samos, is less clear, more astringent, and less strong. No. 10, from Smyrna, has the color of Port wine, and is sour, astringent, and unpleasant, tasting strongly of the skin of the grape. The sourness appears to have been derived chiefly at least from the grape, and not from fermentation. It was about eighteen months old when analyzed; called, however, by Mr. Van Lennep, a *new wine.* In short, these specimens exhibit a good deal of variety of character, and are, therefore, favorable for the object in view.

It will be seen that in all cases except the first, which I conceived to be of little importance, I performed two analyses of each specimen; and I have given both results, that chemists might judge how much dependence is to be placed upon my researches. In No. 2 the difference in the amount of alcohol by the two processes amounts to 1·2 per cent. In the other cases, the difference is less; and it seems to me we are warranted in concluding, that my mean results do not vary more than one per cent. from the truth in any case. And this is near enough for all the purposes for which the analysis was undertaken.

It appears that in all cases except Nos. 7 and 8, the specific gravity of the wines before distillation was greater than that of water. No. 4, from Lebanon, was much heavier; in part probably because the juice was concentrated before fermentation, and in part because it is so old. It yields, of course, a large per cent. of solid matter.

The difference in the results, according to the tables used, is just what we might expect from the different standards assumed by Tralles, Gilpin, and Lowitz, and from the fact that the table of the latter gives the per cent. by weight, whereas all the others give it by measure. Gilpin's tables have been most commonly made the standard, but they convey erroneous conclusions; that is, as the subject is usually understood, they indicate more alcohol in fermented liquors than they contain.

The results which I have now given, justify, it seems to me, the following conclusions.

In the first place, the grapes of Palestine, Syria, and the Levant generally, produce wines as strongly alcoholic as those of any country whose soil and climate are congenial to the vine.

It has been thought that the great quantity of sugar which must exist in the grapes of those countries, and the heat of the climate, are so unfavorable to fermentation that little or no alcohol can be produced from them. But here we have ten specimens of the common wines of those countries, all of which belong to the class of the strong wines. It may be thought that the strongest wines were selected by Mr. Van Lennep. But I particularly requested him not to do it, desiring him to send me rather the common wines. And the apprehension which he expressed that they would all be soured before reaching this country, shows that he supposed them to be quite weak. I incline to believe that their strength is not above the average in those countries; and yet by consulting the analyses of Brande, Beck, Fontenelle, &c. we shall see that they rank among the stronger wines. And indeed this is just what the chemist would expect. For if those countries furnish the finest grapes, they doubtless contain a large amount of the sugar and ferment requisite for the production of alcohol.*

In the second place, we have every reason to believe that the ancient wines of the countries under consideration possessed essentially the same character as the modern wines made there.

There has been no important change in the climate, and of course the grapes now produced there, are the same essentially as in ancient times. If the wines are different, then, it must be the result of different modes of making them. And I am not aware of any important difference in this respect, unless it be in those cases (and whether there be any such cases I know not) in which the wines are enforced by the addition of distilled liquor: but such a case affects not my present argument, because I have analyzed only those which are derived from the pure juice of the grape. Much indeed has been said about the practice of the ancients of boiling down the juice of the grape more or less, before allowing it to ferment. But the same practice exists now, nor is there any reason to believe that it was ever general, but resorted to only to furnish an agreeable variety. And it so happens, fortunately, that one of the specimens analyzed, viz. from Mount Lebanon, is a wine thus prepared; and it may stand as a representative of that class of wines. It is, indeed, the weakest wine of the number; and we learn from this fact that this process does affect the amount of alcohol. And yet this specimen contains about eleven per cent. of pure alcohol, and twenty two per cent.

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* Since the above was written, I have had the pleasure of meeting Mr. Van Lennep in this country, and he confirms all the statements made in the text respecting the strength of the wines. He is even of opinion that those from the neighborhood of Smyrna are below the average strength of the wines of that region. Rev. Mr. Sherman, also, who obtained the specimens from the vicinity of Hebron, and whom I have lately seen, thinks that they may be somewhat stronger than the average of wines in that region. The specimens from Mount Lebanon were procured by Rev. Leander Thomson, who is also in this country, but I have not met with him.

of brandy,—enough certainly to make the wine quite intoxicating. Yet it is quite sweet, and therefore sweetness does not prove that a wine is unintoxicating. When the juice of the grape is boiled down, so as to become thick like honey, or even solid, then, indeed, it cannot ferment, and may be kept an indefinite length of time without containing alcohol. Such was sometimes the case among the ancients; but whether the wine which they called *defrutum*, in which the juice was boiled away only one half, was of this character, that is, thick enough to prevent all fermentation, I much doubt. This inspissated juice of the grape was rather regarded as honey, and so it is called in the Bible, and at the present day in the eastern world it is a very common article; but so far as I can learn, by inquiring of several missionaries, it is not called wine, but is rather a substitute for our honey or molasses. Admitting however that this article was sometimes called wine by the ancients, (and I have no doubt of the fact,) its use as a beverage must necessarily have been quite limited, and therefore this fact does not invalidate my general conclusion, that the character of the ancient and modern wines in eastern countries was essentially the same. This conclusion, at which Prof. Beck arrived by chemical considerations, in his valuable paper on the analysis of wines in this Journal, (Vol. XXVIII,) seems now to be still farther confirmed by experiment.

I trust that in arriving at such conclusions, it will not be imagined that I wish to take away any support, or do in fact take away any support, from the noble cause of temperance, which I have endeavored for so many years to sustain both theoretically and practically. True, some able friends of this cause have supposed the ancient wines to be mostly unintoxicating. But I rest and always have rested its support on very different grounds than the per cent. of alcohol in the wines of Syria and Palestine. But this is a point irrelevant to the present paper, and therefore I waive it. To find out the exact truth should be the object of every scientific investigation, however it may affect opposing opinions.

In the paper of Prof. Beck just spoken of, he has given the analysis of a few samples of American cider; and he found in them only the average per cent. of 4·68; whereas Prof. Brande gives the average of 7·54 per cent. as the amount in English cider. I have never been able to see the reason of so much difference between English and American cider, any more than I could see the reason why the wines of Palestine and Syria should not be as strong as those of any other wine country; and I have suspected that the specimens analyzed by Prof. Beck must have been the very weakest of our cider. While engaged upon the wines of western Asia, therefore, I made some effort to obtain and analyze samples of cider. And although I have not operated upon as many varieties as would be desirable, and they were not obtained from so wide a range as I could wish, yet I give the results of the analyses which I have made. The specimens were all procured from the farmers of Amherst or its vicinity, and in all cases the cider had been kept in casks; nor had any special care been taken in its preparation. Nos. 1, 2, and 4, also abounded in carbonic acid when first analyzed, and were less than six months old, and could not therefore have reached their maximum of alcoholic strength, so that I repeated the process several months afterwards in August. And upon the whole, I feel confident that the results do not exceed the average amount of alcohol in New England cider.

*Results of the Analysis of New England Cider.*

| LOCALITY. | Specific gravity before distillation. | Specific gravity after distillation. | Per cent. of solid matter. | Per cent. of alcohol by measure by Tralles' tables, sp. gr. standard alcohol 0·7946, at 60° F. | Per cent. by Gilpin's tables, sp. gr. of standard alcohol, 0·825. | Per ct. by weight by Lowitz's tables, sp. gr. of standard alcohol, 0·796. | Per cent. of brandy. |
|---|---|---|---|---|---|---|---|
| No. 1. Amherst, 5 months old, | 1·0207 | 0·9915 | 2·86 | 5·3 | 5·73 | 5·6 | 10·72 |
| 2d trial, August 2d, | | 0·9888 | | 7·4 | 8·00 | 7·8 | 14·97 |
| No. 2. Amherst, 5 months old, | 1·0114 | 0·9915 | 1·96 | 5·3 | 5·65 | 5·5 | 10·72 |
| 2d trial, August 2d, | | 0·9899 | | 6·5 | 6·93 | 6·7 | 13·40 |
| No. 3. Amherst, 5 months old, | 1·0002 | 0·9904 | 0·98 | 6·2 | 6·65 | 6·7 | 12·54 |
| No. 4. Amherst, 5 m'ths old, sweet apples, | 1·0087 | 0·9897 | 1·88 | 6·7 | 7·24 | 7·4 | 13·55 |
| 2d trial, August 2d, | | 0·9888 | | 7·4 | 8·00 | 8·2 | 14·99 |
| No. 5. Amh. 5 m'ths old, mostly sweet app. | 1·0021 | 0·9832 | 1·39 | 7·9 | 8·54 | 8·9 | 15·98 |
| No. 6. Deerfield, 2½ years old, | 0·9986 | 0·9897 | 0·89 | 6·7 | 7·24 | 7·4 | 13·55 |
| No. 7. Amherst, 5 months old, | 1·0068 | 0·9888 | 1·79 | 7·4 | 8·02 | 8·3 | 14·97 |
| No. 8. Currant wine, at least 5 years old, | 1·1099 | 0·9887 | 10·92 | 7·5 | 8·11 | 8·4 | 15·17 |

Nos. 3, 5, and 7, although but five months old, and those winter months, appeared nevertheless to have nearly completed their fermentation. No. 5 was from near the bottom of the cask, most of it having been drank; but it was not sour. No. 6 was from a cask almost emptied, which had been kept entirely closed for two and a half years, so that it had not changed at all to vinegar. The apples produced on the rich alluvion of Deerfield, from which this specimen was made, are usually of a rather inferior quality. I have added the analysis of a single specimen of currant wine, partly to show the enormous quantity of solid matter. This wine, although sweet and pleasant, was not clear, and does not contain half as much alcohol as the specimen analyzed by Brande. Probably it had lost some of its alcohol by long keeping, or it was not skillfully prepared.

Prof. Brande gives two averages of the strength of cider; the highest, 9·87 per cent. of alcohol, and the lowest, 5·21 per cent.; the mean of which, as already stated, is 7·54 per cent. The mean of the above seven analyses of New England cider, by Gilpin's tables, which were employed by Brande, is 7·62. From this result, I think we may safely infer that the cider of New and Old England possesses about the same alcoholic strength.

It has been strongly maintained of late, "that sweet apples will not yield strong cider," (*Anti-Bacchus*, p. 166,) nay, that "it is impossible to obtain strong alcoholic cider out of very sweet apples." (*Ibid.* p. 203.) I find, however, that the contrary of this is maintained by all the farmers and distillers with whom I have conversed; and the strongest specimens given in my analyses were from sweet apples. This view appears to me also to be most consonant to the principles of chemistry, provided only that sweet apples contain a quantity of ferment corresponding to that of the sugar.

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## Art. V.—*Statement of Elevations in Wisconsin;* by I. A. Lapham, of Milwaukee, Wis.

In a late number of this Journal is an article by Charles Whittlesey, Esqr., giving the elevation of various places in New York, Pennsylvania, Ohio and Michigan; and as it appears to be desirable to publish additional observations of this kind, the following are furnished for the purpose of extending the series through this territory. Most of the following heights were ascertained by the writer, in the explorations relative to the Milwaukee and

Rock River canal; some are estimated by levels taken at the various rapids along the rivers and adding for the distances between, what is ascertained, in other cases, to be about the average descent of rivers of similar character. These are marked by an interrogation. ? These elevations were taken with reference to the surface of Lake Michigan as a zero, which is thirteen feet above Lake Erie, and consequently five hundred and seventy eight feet above the ocean.* In the following table, this number has been added, so as to give the elevation above the ocean in each case.

| | Feet. |
|---|---|
| Rock river at its source near Lake Winnebago, . | 894 ? |
| " " at a point opposite La Belle Lake, . | 835 |
| " " Jefferson or "the Forks," . . . | 764 |
| " " Lake Koshkonong, (an expansion of Rock river,) . . . . . . | 753 |
| " " at Beloit, (south line of the Territory,) | 706 |
| " " at its mouth, (191 feet descent from state line, Capt. Cram,) . . . . | 515 |
| Pishtaka† river at head marsh, . . . . | 825 |
| " " at junction of Pewaukee outlet, . | 808 |
| " " at foot of rapids at Prairieville, . | 789 |
| " " at Elgin, (30 miles below Territorial line, William Gooding's report,) | 693 |
| Pewaukee Lake, a source of Pishtaka, . . . | 831 |
| Bark river near Pewaukee summit, . . . | 904 |
| Pewaukee summit, (M. and R. R. Canal,) . . | 894 |
| Nagowicka Lake, (an expansion of Bark river,) . | 882 |
| Nemahbin Lake, " " . . | 867 |
| Silver Lake, (in the town of Summit, Milwaukee Co.) | 857 |
| Oconomewoc Lake, . . . . . . | 860 |
| Labelle Lake, . . . . . . . | 851 |
| High ground between Labelle Lake and Rock river, | 835 |
| " " west of Pewaukee Lake, . . . | 971 |
| Surface of Milwaukee river four miles above the city at head of rapids, (37 feet above Lake Michigan,) . | 615 |
| Hills surrounding Milwaukee, (50 to 110 feet,) . | 688 |
| Lake Winnebago, . . . . . . . | 738 ? |

* Higgins' Michigan Geological Report, 1838—9.

† Or "Fox river of the Illinois."

| | Feet. |
|---|---|
| Portage between Wisconsin and Neenah* rivers, . | 801 ?† |
| Wisconsin river at Helena, . . . . . . | 748 ? |
| Top of Blue Mound, (1000 feet above Wisconsin at Helena, Locke,) . . . . . . | 1748 ? |
| Mississippi River, at mouth of Wisconsin, . . | 686 ? |
| Surface of Lake Superior, . . . . . . | 596 |

The geological character of this portion of the Territory is very simple. The whole space from Lake Michigan to the "mineral district," west of Rock river, and from the southern extreme of Lake Michigan northward, nearly to the south line of the "upper peninsula" of Michigan, is occupied (so far as is at present known,) by one vast bed of limestone, disposed in nearly horizontal layers, of a light color, and nearly destitute of organic remains. It is referable, probably, to the "cliff limestone" of Dr. Locke. It is not certain however, but that the "blue limestone" may be found within this district, and also the "Archimedes limestone" of Mr. Owen, but the limited knowledge we have of this great calcareous deposite, does not allow of a decision on these points.

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* Or "Fox river of Green Bay."

† This estimate is based upon the survey of the Neenah and Wisconsin rivers, by Capt. T. J. Cram of the U. S. Engineers, who accurately leveled the several rapids below Lake Winnebago, and reports them as follows:—

| | Feet. |
|---|---|
| Rapide des Péres, - - - - - - - - - - | 3·484 |
| Little Kakalin, - - - - - - - - - - | 2·516 |
| Rapide de Croche, - - - - - - - - - | 1·171 |
| Grand Kakalin, - - - - - - - - - - | 44·059 |
| Little Chute, - - - - - - - - - - | 31·000 |
| Grand Chute, - - - - - - - - - - | 29·682 |
| Winnebago rapids, - - - - - - - - - - | 7·543 |
| Fall in the river between the rapids, (estimated) 40 miles, - - | 40·545 |
| Fall in the river from Portage to Lake Winnebago, 126 miles, - | 63·000 |
| Level of Lake Michigan, - - - - - - - - | 578·000 |
| Total, - - - - - - - - - - - - | 801·000 |

This note is made to correct an error of Mr. Higgins, (Geological Report of Michigan, 1838—9, pp. 49, 50,) where the elevation of this portage is stated at only 121 feet above Lake Michigan, (699 above the ocean,) which error is quoted by Mr. Whittlesey in the article referred to. The principal error is in the descent of the Little Chute, which Capt. Cram found to be 31 feet, but Mr. H. states it at 1·5 feet; which must be a typographical or a *topographical* error.

Art. VI.—*List of Birds found in the vicinity of Carlisle, Cumberland County, Penn., about Lat.* 40° 12′ *N., Lon.* 77° 11′ *W.;* by William M. and Spencer F. Baird.*

The following list embraces the species of birds procured by us in Cumberland County, and with a few exceptions within five miles of the town of Carlisle, during a period of four years. These were obtained by our own personal exertions, and observed whilst living in our fields, woods and mountains, by our running streams and marshes, and in no instance are any placed in the list upon the authority of other persons. Probably but few remain to be found in the county, as every part of it has been searched, and if any have escaped observation, it is likely they are species belonging to the Sylvicolidæ or Fringillidæ, which from their habits, small size, and generic features of resemblance, may have been confounded with others which are well known.

Our object in giving this list is to show at one view the season of migration, the comparative variety or abundance, &c. of the birds found in the *interior of Pennsylvania.* As might readily be imagined, land-birds largely predominate, there being no large rivers in Cumberland County, if we except the Susquehanna, which forms the eastern boundary, and which at this place flows rapidly over a rocky bed, serving only as a resting place for a few aquatic species when forced to alight whilst migrating, from bad weather or other causes, and affording no mud-flats or sand-bars, favorite resorts of the waders. Residing, as we do, eighteen miles from the Susquehanna, possibly some species pursue that river's course in travelling north or south which may have escaped our observation, and would have been noticed had we been living on its banks.

Much has been done towards elucidating the habits of our birds by Wilson, Audubon, and our other writers on the subject, and when the vastness of their field of observation is taken into consideration, no one will be inclined to deny that their success has been very great. But the greatness of their undertaking, the whole of the United States and parts of Texas having been explored by them, has prevented minute attention to the ornithology

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* Communicated by the Authors.

of particular sections. They too were almost constantly travelling, and of course could not ascertain as much respecting the periods of migration at particular places as can be done by more humble ornithologists who are obliged to glean in the field of knowledge where their predecessors have reaped so rich a harvest. These writers have given us the outlines (if we may so speak) of the ornithology of that part of America north of the Gulf of Mexico, but many blanks remain to be filled up; much still depends upon local observation, and many facts must be gathered by observers of small districts—men who have the objects of their attention and inquiry constantly before their eyes, before this branch of science can be as perfectly understood as it is in Great Britain. On the importance of this mode of observation, Swainson and Richardson, in their admirable work on the zoology of British America, remark:

"The discovery of the laws which regulate the distribution of species on the face of the globe being one of the most important ends of the publication of local faunæ, the scanty contributions of facts that we have been enabled to make are thrown for the greater facility of reference into a tabular form. The new world is peculiarly adapted for researches of this kind; its two extremities, and almost every intermediate zone are accessible, and it is to be hoped will hereafter be minutely investigated for the purpose of natural science. When accurate lists of the resident birds in each region, and of the summer and winter visitors are obtained, many highly interesting and unexpected deductions will doubtless be made, and much theoretical reasoning exploded. The Prince of Musignano has performed a great service to science by furnishing such a list for the neighborhood of Philadelphia."—*Fauna Boreali Americana*, Introduction, p. 17.

Much too may be done in the way of correcting mistakes into which our ornithologists have fallen for reasons above stated. Many birds spoken of by Audubon, our latest writer, as "extremely rare" in the United States, have been found to be very common with us, and others supposed not to visit Pennsylvania, are frequently met with. We might cite instances, but the list will show facts of this nature. Nor need any young observer despair of finding what is even *new*, as the writers of this paper have procured two species within the narrow limits of their field which were previously unknown to science, and descriptions of which are subjoined. Many species are *very local* in their habits, and may frequently be found in a particular spot, and scarcely at all in any other, influenced perhaps by the abundance of food in that place, security from molestation, &c.; to which place chance may direct the student of nature, and he be rewarded by finding what is entirely new to naturalists. But our remarks are already far too much extended, and we give the list.

The addition of an obelisk (†) indicates that the species breeds with us; and the dates, the time of appearance.

1. Cathartes aura, Ill.,† Turkey Buzzard. Rather rare; not often seen in winter.
2. Haliætos leucocephalus, Linn.,† Bald Eagle. Resident.
3. Pandion Carolinensis, Gm., Fish Hawk. 1841, April 10; 1842, April 6; 1843, April 15. Common in spring; migratory.
4. Butætes Sancti-Johannis, Bon., Rough-legged Hawk. But one individual seen.
5. Buteo borealis, Gm.,† Red-tailed Hawk. Resident; common.
6. Buteo lineatus, Gm., †? Red-breasted Hawk. Probably resident; common in winter.
7. Buteo Pennsylvanicus, Wils., Broad-winged Hawk. Rare.
8. Falco Columbarius, Linn., Pigeon Hawk. Rare.
9. Cerchneis sparverius, Linn.,† Sparrow Hawk. Abundant; resident.
10. Accipiter fuscus, Gm.,† Slate-colored Hawk. Resident; most abundant of all our species.
11. Accipiter Mexicanus, Sw.?† Five specimens procured; resident?
12. Astur Cooperi, Bon.,† Cooper's Hawk. Resident; rather common.
13. Strigiceps uliginosus, Bon., Marsh Hawk. Rare; in spring and fall.
14. Nyctea candida, Bon., Snowy Owl. Rare; in cold winters.
15. Scops Asio, Gm.,† Screech Owl. Abundant; resident.
16. Bubo Virginianus, Gm.,† Great-horned Owl. Abundant; resident.
17. Otus Americanus, Bon.,† Long-eared Owl. Rare; resident.
18. Brachyotus palustris, Gould, Short-eared Owl. Abundant; not seen in summer.
19. Ulula nebulosa, Linn.,† Barred Owl. Abundant; resident.
20. Nyctale Acadica, Gm., Acadian Owl. Rare; two individuals seen.
21. Antrostomus vociferus, Vieill., Whippoorwill. Abundant in the mountains and in hilly situations; migratory.

22. Chordeiles Virginianus, Briss.,† Night Hawk. 1840, May 2; 1841, May 1; 1842, April 29; 1843, May 4. Very abundant; migratory.

23. Chætura Pelasgia, Linn.,† Swift, Chimney Swallow. 1840, April 17; 1841, April 17; 1842, April 18; 1843, April 20. Very abundant; migratory.

24. Progne purpurea, Linn.,† Purple Martin. 1840, April 3; 1841, April 3; 1842, March 28; 1843, April 11. Abundant; migratory.

25. Chelidon bicolor, Vieill.,† White-bellied Swallow. 1840, March 16; 1841, April 3; 1842, April 12. Rather common; migratory.

26. Cotyle riparia, Linn., Bank Swallow. Rare in spring, abundant in fall; migratory.

27. Hirundo serripennis, Aud.,† Rough-winged Swallow. 1841, April 3; 1842, April 2; 1843, April 20. Very abundant; migratory; replaces Bank Swallow in summer.

28. Hirundo fulva, Vieill.,† Cliff Swallow. 1840, very rare; 1841, rare; 1842, rather common; 1843, common. Increasing in numbers every year; migratory.

29. Hirundo rufa, Bon.,† Barn Swallow. 1840, April 10; 1841, April 17; 1842, April 9; 1843, April 20. Abundant; migratory.

30. Bombycilla Carolinensis, Briss.,† Cedar Bird. 1840, late in May; 1841, late in May; 1842, late in May; 1843, late in May. Large flocks in winter of 1842–43, but generally rare in winter; resident.

31. Ceryle Alcyon, Linn.,† King Fisher. Abundant; rather rare in winter; resident.

32. Trochilus colubris, Linn.,† Ruby-throated Humming Bird. 1841, May 11; 1842, May 16; 1843, May 5. Very abundant; migratory.

33. Sitta Carolinensis, Linn.,† White-bellied Nuthatch. Abundant; resident.

34. Sitta Canadensis, Linn., Red-bellied Nuthatch. Very rare; in winter only.

35. Certhia Americana, Bon., Brown Creeper. Abundant; migratory.

36. Mniotilta varia, Vieill.,† Black and White Creeper. 1840, April 18; 1841, April 20; 1842, April 25; 1843, April 28. Abundant; migratory.

37. Thryothorus palustris, Wils.,† Marsh Wren. Rare; migratory.

38. Thryothorus Bewickii, Aud.,† Bewick's Wren. 1840, not seen; 1841, May 18, rare; 1842, May 13, rare; 1843, May 1, abundant. Migratory; increasing in numbers.

39. Troglodytes Ædon, Vieill.,† House Wren. 1841, April 28; 1842, April 25; 1843, April 29. Migratory; abundant.

40. Troglodytes hyemalis, Vieill., Winter Wren. Winter visitor; abundant.

41. Sialia Wilsonii, Sw.,† Blue Bird. 1840, Feb. 20; 1841, March 1; 1842, Feb. 12; 1843, Feb. 25. Abundant; migratory.

42. Turdus migratorius, Linn.,† Robin. 1840, Feb. 20; 1841, March 1; 1842, Feb. 28; 1843, Feb. 25. Abundant; a few individuals seen in winter.

43. Turdus Mustelinus, Gm.,† Wood Thrush. 1842, May 6. Rather common; migratory.

44. Turdus solitarius, Wils., Hermit Thrush. 1840, April 18; 1841, April 13; 1842, April 12; 1843, March 21. Rather common, spring and fall; migratory.

45. Turdus Wilsonii, Sw., Wilson's Thrush. 1840, April 10; 1841, May 6; 1842, May 6; 1843, May 16. Rather common; migratory.

46. Turdus minor, Gm., Lesser Thrush. 1842, May 13; 1843, May 9. Common; migratory.

47. Mimus polyglottus, Linn.,† Mocking Bird. Very rare.

48. Mimus rufus, Linn.,† Brown Thrush. 1840, April 4; 1841, April 26; 1843, March 22. Abundant; migratory.

49. Mimus felivox, Vieill.,† Cat-Bird. 1840, April 25; 1841, May 6; 1842, April 29; 1843, May 2. Abundant; migratory.

50. Anthus Ludovicianus, Licht., Brown Titlark. 1841, May 3; 1842, April 30; 1843, April 11. Abundant; migratory; large flocks in spring and fall.

51. Regulus satrapa, Licht., Golden-crowned Wren. 1840, March 18; 1841, March 24; 1842, Feb. 21. Abundant in spring, fall, and winter.

52. Regulus calendula, Licht., Ruby-crowned Wren. 1840, April 4; 1841, April 15; 1842, April 2; 1843, April 20. Abundant, spring and fall.

53. Parus atricapillus, Linn.,† Black Cap Tit. Abundant; resident.

54. Parus bicolor, Linn.,† Tufted Tit. Abundant; resident.

55. Parula Americana, Lath.,† Blue Yellow-backed Warbler. 1840, April 25; 1841, April 20; 1842, April 25; 1843, April 28. Very abundant; migratory.

56. Trichas Marilandica, Linn.,† Maryland Yellow-Throat. 1840, May 2; 1841, May 12; 1842, April 30; 1843, May 2. Abundant; migratory.

57. Trichas Philadelphia, Wils., Mourning Warbler. 1840, May 23; 1841, May 12; 1842, May 19; 1843, May 20. Fifteen specimens obtained; migratory.

58. Vermivora Pennsylvanica, Sw.,† Worm-eating Warbler. 1840, May 12, rather common; 1841, rare; 1842, May 6, common; 1843, very rare. Migratory; rare.

59. Vermivora solitaria, Wils.,† Blue-winged Yellow Warbler. 1841, May 20. Very rare; migratory.

60. Vermivora peregrina, Wils., Tennessee Warbler. 1840, not seen; 1841, one seen; 1842, very abundant in autumn; 1843, not seen. Migratory.

61. Vermivora rubricapilla, Wils.,† Nashville Warbler. 1840, rare; 1841, May 1, rare; 1842, April 29, common; 1843, May 6, abundant. Migratory.

62. Seiurus aurocapillus, Sw.,† Golden-crowned Thrush. 1840, April 30; 1841, May 3; 1842, May 4. Abundant; migratory.

63. Seiurus Noveboracensis, Gm.,† Water Thrush. 1841, April 26; 1842, April 25; 1843, April 22. Abundant; migratory.

64. Sylvicola coronata, Lath., Yellow-rumped Warbler. 1840, April 18; 1841, April 20; 1842, April 22; 1843, April 20. Exceedingly common; seen very rarely in winter.

65. Sylvicola petechia, Lath., Yellow Red-Poll Warbler. 1840, April 27; 1841, April 28; 1842, April 30. Common; migratory.

66. Sylvicola maculosa, Lath., Black and Yellow Warbler. 1840, May 16; 1841, May 13; 1842, May 6; 1843, May 9. Abundant; migratory.

67. Sylvicola maritima, Wils., Cape May Warbler. 1840, April 30; 1841, May 11; 1842, May 17; 1843, May 9. Rare; twelve specimens obtained; migratory.

68. Sylvicola pardalina, Bon.,† Canada Fly-catcher. 1840, April 25; 1841, May 11; 1842, May 11; 1843, May 6. Abundant; migratory.

69. Sylvicola virens, Lath.,† Black-throated Green Warbler. 1840, May 13; 1841, May 4; 1842, May 6; 1843, May 5. Common; migratory.

70. Sylvicola Blackburnia, Lath.,† Blackburnian Warbler. 1840, May 6, rare; 1841, May 5, abundant; 1842, May 9, abundant; 1843, May 5, abundant. Exceedingly common some seasons; migratory.

71. Sylvicola icterocephala, Lath.,† Chestnut-sided Warbler. 1840, May 6, rare; 1841, May 13, abundant; 1842, not seen; 1843, May 6, common. Exceedingly common in 1841; migratory.

72. Sylvicola castanea, Wils., Bay-breasted Warbler. 1840, May 16; 1841, May 13; 1842, May 17; 1843, May 8. Common; migratory.

73. Sylvicola striata, Lath., Black-Poll Warbler. 1841, May 22; 1842, May 16; 1843, May 17. Abundant; migratory.

74. Sylvicola Pinus, Lath.,† Pine-Creeping Warbler. 1841, April 24; 1842, April 29; 1843, April 22. Rare in spring, abundant in fall; migratory.

75. Sylvicola parus, Wils.? Hemlock Warbler. Seen only in autumn; migratory.

76. Sylvicola æstiva, Lath.,† Yellow-Poll Warbler. 1840, April 25; 1841, April 21; 1842, April 28; 1843, April 22. Abundant; migratory.

77. Sylvicola Canadensis, Lath.,† Black-throated Blue Warbler. 1840, April 25; 1841, May 4; 1842, May 4; 1843, April 28. Abundant; migratory.

78. Sylvicola cærulea, Wils., Cærulean Warbler. 1842, May 9, one seen. Exceedingly rare; migratory.

79. Wilsonia mitrata, Lath.,† Hooded Warbler. 1843, May 9. Very rare; migratory.

80. Wilsonia pusilla, Wils., Green Black-cap Fly-catcher. 1840, May 6; 1841, May 17; 1842, May 9; 1843, May 18. Abundant; migratory.

81. Setophaga ruticilla, Linn.,† American Redstart. 1840, April 25; 1841, May 8; 1842, May 4; 1843, May 8. Abundant; migratory.

82. Tyrannula flaviventris, Baird, Yellow-bellied Fly-catcher. 1840, late in May; 1841, late in May; 1842, late in May; 1843, May 9. Abundant; migratory.

83. Tyrannula minima, Baird,† Least Fly-catcher. 1841, May 4; 1842, April 29; 1843, May 2. Abundant; migratory.

84. Tyrannula Trailli, Aud., Traill's Fly-catcher. 1841, May 22; 1842, May 17; 1843, May 20. Rather common; migratory.

85. Tyrannula virens, Linn.,† Wood Pewee. 1840, May 18; 1841, May 10; 1842, May 9; 1843, May 8. Abundant; migratory.

86. Tyrannula fusca, Gm.,† Pewee. 1840, April 2; 1841, March 4; 1842, March 10; 1843, April 1. Abundant; migratory.

87. Tyrannus Cooperi, Bon., Cooper's Fly-catcher. 1843, May 6. Very rare; migratory.

88. Tyrannus intrepidus, Vieill.,† King-Bird. 1841, May 1; 1842, April 28; 1843, April 22. Abundant; migratory.

89. Tyrannus crinitus, Linn.,† Great-crested Fly-catcher. 1840, April 25; 1841, May 1; 1842, April 25; 1843, April 28. Abundant; migratory.

90. Icteria viridis, Gm.,† Yellow-breasted Chat. 1841, May 18; 1842, May 19. Rare; migratory.

91. Vireo flavifrons, Vieill.,† Yellow-throated Vireo. 1840, May 13; 1841, May 12; 1843, May 6. Common; migratory.

92. Vireo solitarius, Vieill.,† Solitary Vireo. 1841, April 21; 1842, April 21; 1843, April 28. Abundant; migratory.

93. Vireo gilvus, Vieill.,† Warbling Vireo. 1840, April 24; 1841, April 28; 1842, April 30; 1843, April 28. Very common; migratory.

94. Vireosylva olivacea, Linn.,† Red-eyed Vireo. 1840, May 13; 1841, May 12; 1842, May 9; 1843, May 6. Abundant; migratory.

95. Lanius septentrionalis, Gm., Great Northern Shrike. Rather common in winter; migratory.

96. Cyanocorax cristatus, Linn.,† Blue Jay. Abundant; resident.

97. Corvus Americanus, Aud.,† American Crow. Very abundant; resident.

98. Corvus Catototl, Wagler, Raven. Very rare; in winter.

99. Quiscalus versicolor, Vieill.,† Purple Grakle. 1842, March 3. Very common; migratory.

100. Scolecophagus ferrugineus, Lath., Rusty Grakle. 1841, March 4; 1842, March 3; 1843, March 22. Abundant, spring and fall; migratory.

101. Sturnella Ludoviciana, Linn.,† Meadow Lark. Abundant; resident.

102. Icterus Baltimore, Daud.,† Baltimore Oriole. 1840, April 24; 1841, May 3; 1842, April 25; 1843, April 28. Abundant; migratory.

103. Icterus spurius, Gm.,† Orchard Oriole. 1840, April 25; 1842, April 29; 1843, April 28. Abundant; migratory.

104. Agelaius Phæniceus, Vieill.,† Red-winged Blackbird. 1840, Feb. 20; 1841, March 1; 1842, Feb. 28; 1843, March 12. Very abundant; migratory.

105. Molothrus pecoris, Gm.,† Cow Bunting. 1841, April 6; 1842, March. Abundant; one seen in winter.

106. Dolichonyx Oryzivorus, Linn., Reed Bird. 1840, May 22; 1841, May 8; 1842, May 4; 1843, May 16. Very abundant in autumn; migratory.

107. Guiraca cærulea, Linn.,† Blue Grosbeak. 1841, May 18; 1842, May 12; 1843, May 16. A few seen each year in same place; migratory.

108. Guiraca Ludoviciana, Linn.,† Rose-breasted Grosbeak. 1840, May 2; 1841, May 6; 1842, May 9; 1843, May 8. Rare; migratory.

109. Struthus hyemalis, Linn., Snow Bird. A winter visitant; very common.

110. Passerella iliaca, Merrem, Fox-colored Sparrow. 1841, April 17; 1842, March 25; 1843, April 6. Abundant; migratory.

111. Zonotrichia melodia, Wils.,† Song Sparrow. Abundant; resident.

112. Zonotrichia graminea, Gm.,† Grass Finch. 1841, March 30; 1842, March 25; 1843, April 11. Abundant; migratory.

113. Zonotrichia Pennsylvanica, Lath., White-throated Sparrow. 1840, April 11; 1841, April 17; 1842, March 25; 1843, April 22. Abundant; migratory.

114. Zonotrichia leucophrys, Wils., White-crowned Sparrow. 1840, May 13, rare; 1841, very abundant; 1842, May 9; 1843, none seen. Migratory.

115. Euspiza Americana, Gm.,† Black-throated Bunting. 1840, May 15; 1841, May 15; 1842, May 11; 1843, May 2. Abundant; migratory.

116. Coturniculus Passerinus, Wils.,† Yellow-winged Sparrow. 1842, April 30. Abundant; migratory.

117. Passerculus Savana, Wils., Savannah Finch. 1842, abundant; 1843, May 6. Rather common; migratory.

118. Passerculus palustris, Wils.,† Swamp Sparrow. 1842, April 16. Abundant; migratory.

119. Passerculus Lincolnii, Aud., Lincoln's Finch. 1841, May 15, rare; 1842, rare; 1843, May 4, common. Increasing; migratory.

120. Spizella Canadensis, Lath., Tree Sparrow. Abundant in winter.

121. Spizella socialis, Wils.,† Chipping Sparrow. 1840, March 28; 1841, March 26; 1842, April 2; 1843, April 11. Abundant; migratory.

122. Spizella pusilla, Wils.,† Field Sparrow. 1841, April 13; 1842, April 17; 1843, April 11. Abundant; migratory.

123. Chrysomitris tristis, Linn.,† American Goldfinch. Abundant; rarer in winter; resident.

124. Chrysomitris Pinus, Wils., Pine Finch. 1841, seen May 30. Rare; in winter.

125. Linota linaria, Bon., Lesser Redpoll. Some flocks in winter of 1843.

126. Erythrospiza purpurea, Gm., Purple Finch. 1841, April 26; 1842, April 1; 1843, April 20. Abundant; migratory.

127. Cardinalis Virginianus, Bon.,† Cardinal Grosbeak. Very rare.

128. Pipilo erythropthalmus, Linn.,† Towhe Bunting. 1841, April 20; 1842, April 25. Abundant; migratory.

129. Spiza cyanea, Linn., Indigo Bird. 1840, April 27; 1841, May 12; 1842, April 30; 1843, May 6. Abundant; one seen in winter. Migratory.

130. Pyranga rubra, Vieill.,† Scarlet Tanager. 1840, April 27; 1842, May 4; 1843, May 6. Abundant; migratory.

131. Phileremos cornutus, Sw., Shore Lark. Abundant; autumn and winter; migratory.

132. Dryotomus pileatus, Linn.,† Pileated Woodpecker. Rather common; resident.

133. Picus villosus, Linn.,† Hairy Woodpecker. Abundant; resident.

134. Picus Auduboni, Trudeau,† Audubon's Woodpecker. One specimen obtained.

135. Picus ———. One specimen obtained.

136. Picus pubescens, Linn.,† Downy Woodpecker. Abundant; resident.

137. Picus varius, Linn.,† Yellow-bellied Woodpecker. 1840, April 2; 1841, April 15; 1842, April 1; 1843, April 11. Rather common; migratory.

138. Melanerpes erythrocephalus, Linn.,† Red-headed Woodpecker. Abundant; rarer in winter; resident.

139. Centurus Carolinensis, Linn.,† Red-bellied Woodpecker. Abundant; most so in winter; resident.

140. Colaptes auratus, Linn.,† Flicker. Abundant; resident.

141. Erythrophrys erythropthalmus, Wils., Black-billed Cuckoo. 1841, May 17. Common; migratory.

142. Erythrophrys Americanus, Linn.,† Yellow-bellied Cuckoo. 1841, May 18; 1842, May 10; 1843, May 8. Common; migratory.

143. Ectopistes migratoria, Linn.,† Passenger Pigeon. 1841, March 31; 1842, Feb. 4; 1843, April 6. In immense flocks at times; resident; but rare in winter.

144. Ectopistes Carolinensis, Linn.,† Carolina Dove. 1841, March 4; 1842, March 3; 1843, April 8. Very abundant; rare in winter; resident.

145. Meleagris Gallipavo, Linn.,† Wild Turkey. Not common; resident.

146. Ortyx Virginianus, Linn.,† Virginia Quail. Not abundant at present; resident.

147. Bonasia umbellus, Linn.,† Ruffed Grouse. Common; resident.

148. Ægialites vociferus, Linn.,† Killdeer Plover. 1841, March 20; 1842, March 12. Abundant; occasionally in winter.

149. Charadrius Virginiacus, Borkh., American Golden Plover. Exceedingly abundant at times; in autumn only; migratory.

150. Ardea Herodias, Linn.,† Great Blue Heron. 1840, April 4; 1841, April 1; 1842, April 1; 1843, April 11. Rather common; migratory.

151. Egretta leuce, Bon.,† Great White Egret. Rare; migratory.

152. Herodias virescens, Linn.,† Green Heron. 1840, May 2; 1841, April 8; 1842, April 16; 1843, April 20. Abundant; migratory.

153. Botaurus lentiginosus, Sw., American Bittern. 1840, April 25; 1841, April 20; 1842, April 16; 1843, April 28. Rather rare; migratory.

154. Nycticorax Americana, Bon., Night Heron. Young only; in autumn; migratory.

155. Heteropoda semipalmata, Wils., Semipalmated Sandpiper. Rare; in autumn; migratory.

156. Pelidna pectoralis, Say, Pectoral Sandpiper. 1841, April 16; 1842, April 22. Common; migratory.

157. Pelidna pusilla, Wils., Least Sandpiper. 1840, May 16; 1842, May 5. Rare; migratory.

158. Actitis macularius, Wils.,† Spotted Sandpiper. 1840, April 11; 1841, March 30; 1842, March 28; 1843, April 11. Abundant; migratory.

159. Actiturus Bartramius, Wils.,† Bartram's Sandpiper. 1840, April 30; 1841, April 17; 1842, April 12; 1843, April 11. Abundant; migratory.

160. Totanus flavipes, Vieill., Little Yellow-leg. 1841, April 21; 1842, May 4. Common sometimes; migratory.

161. Totanus chloropygius, Vieill.,† Solitary Sandpiper. 1842, April 25. Common; migratory.

162. Totanus melanoleucus, Vieill., Great Yellow-leg. 1840, April 21; 1842, May 5. Rare; migratory.

163. Gallinago Wilsonii, Bon., Wilson's Snipe. 1840, March 18; 1841, March 21; 1842, March 26. Very abundant; spring and autumn; rare in winter.

164. Rusticola minor, Vieill.,† American Woodcock. 1840, Feb. 27; 1842, April 1. Very abundant; very rare in winter.

165. Rallus Virginianus, Linn.,† Virginia Rail. 1841, April 28. Abundant; migratory.

166. Ortygometra Carolina, Linn.,† Carolina Rail. 1841, May 5. Abundant; migratory.

167. Gallinula galeata, Licht.,† Green-legged Gallinule. 1840, May 14. Rare; migratory.

168. Fulica Americana, Gm., American Coot. 1840, March 28; 1841, April 17. Rare; migratory.

169. Lobipes hyperboreus, Lath., Hyperborean Phalarope. One seen Sept. 1842.

170. Anser Canadensis, Linn., Canada Goose. Rare on our streams; migratory.

171. Anas Boschas, Linn.,† Mallard. 1842, March 3. Abundant; rare in winter and summer; resident.

172. Anas obscura, Gm., Black Duck. Abundant, except in summer.

173. Mareca Americana, Steph., Baldpate. 1841, April 8; 1843, April 6. Common; migratory.

174. Chaulelasmus streperus, Linn., Gadwall. Very rare; migratory.

175. Dafila acuta, Linn., Sprigtail. 1842, March 10; 1843, March 11. Abundant; migratory.

176. Rhynchaspes clypeata, Linn., Shoveller Duck. 1841, May 8; 1843, April 20. Rare; migratory.

177. Cyanopterus discors, Linn., Blue-winged Teal. 1840, April 17; 1842, April 16; 1843, April 20. Rather common; migratory.

178. Querquedula Carolinensis, Steph., Green-winged Teal. 1840, Feb. 26; 1841, April 8; 1842, Feb. 28; 1843, April 6. Abundant; migratory.

179. Aix sponsa, Linn.,† Summer Duck. 1840, March 4; 1841, March 30; 1842, March 17; 1843, April 6. Very common; rare in winter.

180. Aythya erythrocephala, Bon., Red-headed Duck. Very rare; migratory.

181. Fuligula marila, Linn., (small var.,) Black-headed Duck. 1841, April 19; 1842, March 17; 1843, April 11. Abundant; migratory.

182. Fuligula refitorques, Bon., Ring-necked Duck. 1843, March 23. Not common; migratory.

183. Clangula Americana, Bon., Golden-eyed Duck. Abundant in winter; migratory.

184. Clangula albeola, Linn., Buffel-headed Duck. Abundant in spring and autumn. Rarer in winter.

185. Harelda glacialis, Linn., South Southerly. Very rare; migratory.

186. Erismatura rubida, Wils., Ruddy Duck. 1841, April 17. Rather rare; migratory.

187. Merganser Castor, Linn., Goosander. Abundant; breeds in the adjoining county of Perry.

188. Merganser serrator, Linn., Red-breasted Merganser. Very rare; migratory.

189. Merganser cucullatus, Linn., Hooded Merganser. 1840, April 15; 1842, April 27; 1843, April 11. Abundant; breeds in Perry County.

190. Hydrochelidon nigrum, Linn., Black Tern. Seen once in autumn; migratory.

191. Xema Bonapartii, Rich., Bonaparte's Gull. Rare; migratory.

192. Sylbeocyclus Carolinensis, Lath.,† Carolina Grebe. 1840, April 2; 1841, April 1; 1842, March 28; 1843, April 11. Abundant; migratory.

193. Podiceps cornutus, Lath., Horned Grebe. Rare; migratory.

194. Colymbus glacialis, Linn., Loon. 1841, April 13; 1842, May 23. Common; migratory.

Besides the above, found in the immediate vicinity of Carlisle, the following have been seen in the eastern border of Cumberland County, on the Susquehanna River.

195. Squatarola Helvetica, Linn.
196. Limosa fedoa, Vieill.
197. Cygnus Americanus, Sharp.
198. Oidemia fusca, Linn.
199. Aythya Vallisneria, Wils.
200. Falco peregrinus, Linn.
201. Larus, (a large species.)

*Summary.*

| | |
|---|---|
| Species spending the summer, . . . . | 112 |
| Species resident all the year, . . . . | 38 |
| Winter visitors, . . . . . . . | 14 |

Besides the birds given in the list, we have ascertained from report that some other species visit us occasionally. Barton, in a work entitled "Fragments of the Natural History of Pennsylvania," states that about the year 1760 large flocks of the Carolina Parakeet, (*Conurus Carolinensis*, Linn.,) were seen in Sherman's Valley, some twelve miles north of Carlisle. So unusual a circumstance caused great terror in the minds of the ignorant settlers, just as the appearance of the Bohemia Chatterer, (*Bombycilla garrula*,) in various parts of the north of Europe, occasions the dread of some evil, which a visit from these birds is supposed to portend. A small Rail, probably *Ortygometra Jamaicensis*, Briss., has sometimes been killed in our vicinity, though not of late years. The Common Crossbill, (*Loxia curvirostra*, Linn.,) is reported by persons living near the mountains, to be frequently seen in winter. A small Ring Plover has also been killed in our neighborhood.

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## *Descriptions of two species, supposed to be new, of the genus Tyrannula, (Swainson,) found in Cumberland County, Penn.* By Wm. M. and S. F. Baird, of Carlisle, Penn.*

For the first of the species hereafter described, we propose the name of *Tyrannula flaviventris*, the bright yellow color of the lower parts constituting a striking feature. The other we have named *Tyrannula minima*, it being the least of all our North American Tyrannulæ.

The similarity in color and size between a number of our small tyrant fly-catchers being very great, we have deemed it best to send with the specimens of the two described, skins of *T. Acadica* and *T. Traillii*, species which most nearly resemble them. By a comparison of the four, the distinctive features of each will at once be perceived.

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* From the Journal of the Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. I, 1843, p. 283.

TYRANNULA FLAVIVENTRIS, (*nob.*)

*Specific characters.*—Above deep greenish olive, beneath bright sulphur yellow, sides and fore part of breast olivaceous. Tail emarginate. Third and fourth primaries longest. Bill brownish yellow beneath.

*Description of a Male.*

*Form, &c.*—Body rather stout. Bill broad and the sides convex. Tarsus longer than the middle toe. Wings rounded; third primary longest, fourth slightly shorter, second one line shorter than third, and two lines longer than fifth, first shorter than fifth, but longer than sixth. Tail emarginate and slightly rounded.

*Color.*—Bill above dark blackish brown, beneath light yellowish brown. Feet brownish black. Plumage of the upper parts deep greenish olive, crown of the head rather darker, the feathers having their centres dark brown. A narrow ring round the eye pale yellow. Lower tail coverts, abdomen, and linings of the wings, bright sulphur yellow, deepest on the abdomen. Sides of the body, fore part of the breast, and sides of the neck, olive, lighter than the back, and inclining to yellowish on the throat. Primaries and tail feathers dark brown, the former bordered with grayish, and the latter with olive like the back. The lower row of lesser wing coverts and the secondary coverts darker, tipped with pale yellow, that color forming two bands across the wing. Secondaries darker than the primaries, and edged with pale yellow.

Length 5 inches 4 lines; extent 8 inches 8 lines; folded wing 2 inches 9 lines.

The sexes are similar in color, but the *female* is generally rather smaller.

*Observations.*—This strongly marked species will at once be distinguished from every other by the deep yellow of its under parts. It resembles *T. Acadica* of Gmelin (*querula* of Wilson) somewhat in form, but *Acadica* by comparison will be found to be a larger bird, lighter olive above, and very pale yellow beneath. The tail of *Acadica* is even or slightly rounded, in this species emarginate.

We have no specimen of *T. pusilla*, of Swainson, but upon comparison with the description in Swainson and Richardson's Zoology of North America, (so favorably known for accuracy,) it appears to differ in the color of the upper parts, *pusilla* being "intermediate between hair brown and oil green;" our species is of a decided olive green: the front of *pusilla* is "hoary;" in our species dark brownish olive: the bands on the wing grayish white; in our species pale yellow: "throat and breast" of *T. pusilla* "pale ash gray;" in this species the throat is yellow, and the breast olive tinged with yellow.

This species was first observed in the spring of 1840, near Carlisle, Penn. During every succeeding spring since, it has been seen in greater or less numbers, and several specimens procured each year. Its habits are much like those of the other species of this genus; it frequents low thickets near small streams, is seldom found in large woods like *T. Acadica* or *T. virens*, and is a very unsuspicious bird, allowing persons to approach within a short distance. It probably goes further north than Pennsylvania to breed, having never been observed after the latter part of May or beginning of June.

### Tyrannula minima, (*nob.*)

*Specific characters.*—Above dark grayish olive, breast light ash gray, abdomen and lower tail coverts yellowish white. Tail emarginate. Second and third primaries longest, first longer than sixth. Bill horn color beneath.

### *Description of a Male.*

*Form, &c.*—Body rather slender. Bill smaller than the other species of the genus. Tarsus slightly longer than the middle toe. Second primary longest, third nearly equal, and rather longer than fourth, fifth one line shorter than fourth, first intermediate between fifth and sixth. Tail emarginate and slightly rounded.

*Color.*—Bill dark blackish brown above, pale horn color beneath. Feet black. Plumage of the upper parts dark grayish olive, crown somewhat darker, rump lighter and inclining to grayish. A narrow ring round the eye grayish white. Fore part of breast, sides, and sides of the neck light ash gray, middle of throat white, rest of the lower parts very pale yellow or yellowish white. Primaries and tail feathers wood brown, the former narrowly, and latter broadly edged with olive. Lower row of lesser wing coverts and the secondary coverts darker, tipped with dirty white, that color forming two bands across the wings. Secondaries also dark, like the greater wing coverts, and broadly edged with yellowish white.

Length 5 inches 2 lines. Extent 8 inches 3 lines. Folded wing $2\frac{1}{2}$ inches.

No perceptible difference as to color or size between the sexes.

*Observations.*—This species will be recognized by its size, its slender form making it the smallest of our North American Tyrannulæ. In color it most resembles *T. Traillii*, of Audubon, but it is a much smaller bird, being nearly three-fourths of an inch shorter. *T. Traillii* has the breast and sides of the neck olivaceous; in this species light ash gray; the tail also of *T. Traillii* is even.

It differs from *T. pusilla* (comparing with the description of Swainson and Richardson as before) in having the wings more pointed, the second and third primaries being longest, and the first longer than the sixth; while in *pusilla* the third and fourth are longest, and the first shorter than the sixth. The upper tail coverts of *pusilla* are uniform in color with the back; in our species lighter: *pusilla* has the front "hoary;" in this species dark. The lower parts of *pusilla* are pale sulphur yellow, "approaching to siskin-green;" in our species yellowish white: the under mandible of *pusilla* is yellowish brown; of this species horn color. From the figure in the Fauna Boreali-Americana, *pusilla* appears to be a stouter bird, much deeper in color beneath and having a broader bill. Its smaller size and darker color above, will distinguish it from *T. Acadica*, (being two-thirds of an inch shorter,) which species has also longer and more pointed wings, a much larger bill which is light brown beneath, and an even tail.

This species was first observed and procured in May, 1839, near Carlisle, Penn. Since then numbers have been observed and shot on every succeeding spring. Like the preceding, (*T. flaviventris*,) this bird does not frequent deep forests, but is found among the scattering trees which border our streams. It is rather shyer than *T. flaviventris*, and does not, like that species, seek dense thickets. It also, most probably, goes further north to breed, as after the last of May it is no longer to be seen. It visits us from the south in the latter part of April, generally making its appearance about a week before *T. flaviventris*.

Art. VII.—*Abstract of a Meteorological Journal, for the year* 1843, *kept at Marietta, Ohio,* Lat. 39° 25′ N., Long. 4° 28′ W. of Washington City; by S. P. Hildreth, M. D.

| MONTHS. | THERMOMETER. Mean temperature. | Maximum. | Minimum. | Fair days. | Cloudy days. | Rain and melted snow, in inches, | Prevailing winds. | BAROMETER. Maximum. | Minimum. | Range. |
|---|---|---|---|---|---|---|---|---|---|---|
| January, - - | 37·00 | 70 | 8 | 14 | 17 | 1·84 | S., S. W. | 29·80 | 28 95 | ·85 |
| February, - | 26 66 | 56 | 2 | 14 | 14 | 2·17 | W., N. W., S. W. | 29·60 | 28 80 | ·80 |
| March, - - | 28 25 | 61 | 0 | 14 | 17 | 3·70 | W., N. W., N. | 29·60 | 29·10 | ·50 |
| April, - - | 51·30 | 84 | 21 | 11 | 19 | 4·75 | W., N. W., S. W. | 29·50 | 28 98 | ·52 |
| May, - - | 60·78 | 89 | 34 | 20 | 11 | 2·96 | N., N. W., S. W. | 29 60 | 29·05 | ·55 |
| June, - - | 68·48 | 90 | 34 | 23 | 7 | 4·21 | S. W., S. | 29·68 | 29·20 | ·48 |
| July, - - | 72·66 | 92 | 49 | 25 | 6 | 1·33 | N., S. | 29·70 | 29·35 | ·35 |
| August, - - | 72·33 | 87 | 50 | 23 | 8 | 1·91 | S., S. W., N. | 29 66 | 29·45 | ·21 |
| September, - | 68 54 | 89 | 42 | 15 | 15 | 9·25 | S , S. W. | 29·75 | 29·35 | ·40 |
| October, - - | 48·33 | 75 | 22 | 13 | 18 | 4·43 | S., S. W., N. | 29 85 | 29·10 | ·75 |
| November, - | 39·93 | 67 | 18 | 9 | 21 | 2·63 | W., N. W., S. W. | 29·75 | 29·15 | ·60 |
| December, - | 35·00 | 56 | 6 | 12 | 19 | 2·58 | W., N. W., S. | 30·00 | 29·18 | ·82 |
| Mean, | 50·77 | | | 193 | 172 | 41·76 | | | | |

*Remarks on the year* 1843.—Although there cannot, according to the present arrangement of the seasons, be any very great difference in the mean temperature of different years, the laws of climate forbidding any wide departure from this rule; yet from various causes there is in many years a striking difference in the temperature, especially as applied to the seasons. This variety most generally arises from the course of the winds, and from the greater or less amount of rain; but much more from the winds than from any other source. Next to the winds, the amount of cloudy weather has considerable influence, by the obstruction this state of the atmosphere opposes to the rays of light and heat from the sun. The past year has been attended with a larger amount of westerly and northerly winds than usual, and also with a greater number of cloudy days. From both these sources we may perhaps account for the low mean annual temperature of this year, being more than two degrees less than the usual amount for this climate, that of 1843 being only 50°·77; the years 1835, 1836 and 1838 were also remarkable for their low temperature.

The mean for the winter months is 32°·33, which is four degrees less than that of the year 1842. The winter of 1843 set in very early, so that the Ohio River was frozen over by the twenty eighth day of November, both above and below Marietta, but continued closed only about a week, when a fall of rain, with a more elevated temperature, set it free. The weather at no time during the winter was very cold; but it continued for a long time, not less than four and a half months, the coldest morning being on the 24th of March, when the mercury sunk to zero, being the lowest during the winter. The mean temperature for February was eleven degrees less than for the same month in 1842. There was but little snow, or rain, the whole amount of both being but seven inches, for the winter months. The winds were chiefly from the west and northwest, which always come to us bearing a small amount of caloric, being deprived of that life-giving property in their passage over the elevated regions of "the far west."

The mean temperature of the spring months was 46°·77, being about ten and a half degrees less than the spring of 1842, which was 57°·11. The most marked difference in the spring months of these two years, was in March and April, the former being 23°·75, and April 8° less than the corresponding months in the year 1842. There was also a remarkable change in the progress of vegetation, the low grade of temperature retarding, as much as the unusual heat of the former year had accelerated its growth; even to the last of March there was but little more appearance of spring than in February. In March my floral journal does not contain the record of the blooming of a single flower, but all were still wrapped in the deep sleep of winter; while in the past year it commenced with the opening of the month. With many plants there was more than a month's difference in the appearance of their blossoms. The contrast is very striking and curious, to a lover of floral horticulture, or an observer of the progress of vegetation in different years. The following dates of the blooming of plants, will contrast curiously with that published for 1842.

April 1st, crocus in bloom; 2d, crown imperial two inches high; 3d, snow fell two inches deep; 4th, blackbird and martin appear; 8th, snowdrop in bloom; 14th, Hepatica triloba; 19th, early hyacinth; 20th, Aronia botryapium, or Juneberry; 21st, crown imperial; 22d, Sanguinaria Canadensis; 23d, hyacinth; 24th, peach tree begins to open its flowers on the sunny side of hills, but not in low grounds; 25th, wood anemone; 26th, fumitory and birthwort; 27th, peach in bloom generally—last year it opened on the 19th of March, a difference of thirty eight days; 29th, plum in bloom. On the morning of the 25th there was a frost, but not so hard as to injure the blossoms of the peach. It is a curious fact, that on the borders of the Ohio River, we rarely fail in having one frost, or more, when the peach is in blossom. This I have noticed for more than thirty years.

May 1st, pear and cherry in bloom; 5th, apple in blossom—last year it was open on the 2d of April, a difference of thirty three days; a few tulips of the early varieties open; 6th, red-bud in bloom—this fine flowering tree usually opens at the same time with the apple; 7th, Cornus florida; 8th, white oak putting out its leaves—the old Indian rule for planting their corn, and was probably founded on ancient observation, that before that period the earth was not sufficiently warmed for the corn to vegetate in a healthy manner; 9th, apple shedding its blossoms; 13th, quince tree in bloom; 16th, purple mulberry; 17th, Calceolaria lutea; 18th, hickory; 19th, black walnut shedding its aments; 22d, Ribes villosus; 24th, Acacia robinia—this is a very cautious tree, and never puts out its bloom till all danger from late frosts is past; 25th, Prunus Virginianus; 27th, rose Acacia, in gardens; 30th, white Chinese peony.

The mean temperature for the summer months was 71°·15, which is 3°·71 above the summer of 1842. The amount of rain in these months was only 7·45 inches, while in the former year it was 15·75 inches. This small amount of rain, less than half that of 1842, will no doubt in part account for the increase of heat, there being less of clouds and more sunshine. June 2d, there was a smart frost in the morning, but not so hard as to destroy the young and tender fruit of pears, apples, &c., it being protected by the shelter, and by the radiation of caloric from the leaves. 7th, Osage orange in bloom; 8th, peas fit for the table—in ordinary years they are ready by the 20th of May. 9th, strawberries ripe; 11th, various hardy roses in bloom; 18th, Franklinia; 23d, cucumbers ready for eating—grown in the open air, but protected when small by a box, like a hand glass; 26th, Sambucus in bloom; 27th, purple mulberry ripe; 29th, red Antwerp raspberry and currant; July 1st, Catalpa in bloom. The ripening of the early summer fruits is not so much retarded by the action of a cold spring, as the blooming of flowers. The hot weather of early summer brings them forward rapidly, as it accelerates the progress of vegetation in a high northern latitude, where corn is ripened in six weeks from the time of the melting of the last of the snow. July and August were very dry months; there falling but a little more than three inches of rain. The excessive drought and scorching heat of the sun, at a time when the Indian corn is setting its ears and perfecting the seed, nearly ruined the crop in all the hilly region of this portion of the state. Potatoes also suffered in the same manner; the product being very small in amount and very poor in quality. The sweet potatoe, which in common years is very productive and finely flavored, was a complete failure, many fields producing but little more than the amount of seed planted. Wheat, the staple crop of the uplands, was very poor. The open character of the winter, with the alternate state of freezing and thawing the ground, detached many of the roots from the soil, and the plants perished. Much that survived the winter, was blighted by rust and mildew, or destroyed by the fly. A steady cold winter, with a good depth of snow, agrees the best with this valuable grain. The crop of peaches was very fine and abundant; the hot dry weather of August ripening this delicious fruit in great perfection. Apples were abundant and of an excellent quality. Melons and grapes both ripened well, and could not complain of a lack of summer heat.

The mean temperature of the autumnal months was 41°·08, being just ten degrees below that of the preceding year. This difference may be explained by the unusual amount of rain, and the prevalence of northerly and westerly winds. For eight or ten weeks the sun did not shine more than a fourth part of the time. The amount of rain in autumn was 16·31 inches; of this quantity there fell in September 9·25 inches. The excessive wet condition of the earth made it very difficult for the farmers to dig their potatoes, gather their corn, or plow their land for the seeding of wheat. Much Indian corn was lost by mould and dampness, there not being sufficient sunshine to dry it. In addition to the other calamities which befell us, especially the smaller farmers, the gray squirrels commenced their depredations on the corn as soon as it was fairly in the milk, and continued them till it was gathered. They were most numerous in September and October, migrating from the woods in the interior in countless hosts;

one man could kill a hundred and more in a day. Fields of five to eight acres were entirely destroyed; in many instances not leaving a bushel of sound corn to the cultivator. The forests produced no nuts or acorns, and the poor squirrels were forced to travel in quest of food or perish. Thousands of them swam across the Ohio River. The years 1807, 1822 and 1843, will long be famous in the annals of Ohio, for the migration and depredations of the squirrel. In December there was a fall of eleven inches of snow, which remained for a few days. The Ohio River has not yet been closed with ice, and steamboats still continue to navigate its waters.

Marietta, January 10, 1844.

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## Art. VIII.—*A Week among the Glaciers;* by Dr. H. Allen Grant.*

We arrived at Chamonix† on Friday evening, July 12th, 1839, and strolled about this small but remarkably situated village. Chamonix is at the base of the monarch of the Alps, and completely surrounded by these stupendous barriers, which Nature has formed, as if to seclude the inhabitants of its peaceful vale from intercourse with, and consequent contamination from the adjoining nations.

Here in the space of a few square miles, has Nature congregated her most gigantic piles, and displayed with wasteful prodigality the immensity of her power. On every side the lofty peaks of the Alpine chain present themselves to the eye, and bound abruptly the limited horizon. While every mountain presents its own peculiar attractions, each possessing advantages denied to all the rest, they stand as opposing rivals, conscious of their own matchless attractions. On the east rises the Montagne Vert, celebrated for its *Mer de Glace* and garden; this is a spot that nearly every traveller visits, and is accessible with no great fatigue and little danger. To the south rises in fearful and majestic height the mighty monarch of the Alps, (Mont Blanc,) flanked on either side by the Dome de Gouté and the Aiguille de Midi, which stand as sentinels to guard the icy pass to the throne of the Alpine king. Nearly all are at first disappointed in the height

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* Communicated by request of the Editors. † Chamouni of many tourists.

which Mont Blanc presents, and this is doubtless from the description either of friends who have visited this spot, or the accounts given in the "hand-books of Chamonix," which describe this mountain as the "dark frowning monarch," &c.

Mont Blanc possesses a character to which such appellations will not apply. It rises far above the surrounding mountains; and as its lofty summit towers above the rest, it impresses the beholder, not with the awful sublimity that does our own impetuous Niagara, but by its grand and majestic serenity the turbulent passions which agitate our bosoms are quelled to silence in contemplating the stillness that rests on its eternal snow-capped heights.

In the valley of Chamonix runs the river Arve, and has for a tributary the Arveron, which issues from beneath the Glacier du Bois, and is visited by all to see the icy arch, which has been formed by the waters of the river, in conjunction with the rays of the sun. Its height varies much in different seasons, and even during the same year; it may be named from thirty to one hundred feet.

The ascension of Mont Blanc is attempted by few. The first successful one was made by Prof. De Saussure, whose valuable researches, and the praiseworthy object he had in view, (the advancement of science,) are sufficient excuse for hazarding the lives of his guides, who are tempted by money to brave the inevitable danger of the journey. Since his ascension it has been attempted by a few adventurers with varied success, and generally with no other motive than mere curiosity or a spirit of bravado. Recently a Dr. Barry of England made a successful ascent, and has published an account of it, with his observations; but owing to the inaccuracy of his instruments, his experiments cannot be relied upon, which we much regret.

By the present arrangement of the government, the ascent of Mont Blanc is very expensive, in consequence of the great number of guides requisite to be taken; and it is also annoying by the forms and ceremonies attendant on such an expedition. When a party intend making the ascent, mass is previously said in the village church, for the safety of the guides and travellers; and the guides, for whom more especially it is said, are obliged to attend. On the whole it is rather an imposing sight, to see these sturdy mountaineers attending this religious ceremony, before attempting to brave the dangers of an ascent.

The attempt to ascend Mont Blanc was to me quite unexpected, for I did not wish to risk for myself the dangers of an ascent, and much less the lives of the guides necessary to such an excursion. But being in company with two English gentlemen, who determined to attempt it, I was persuaded to make it with them.

Having made known our intentions to the *hotelier*, he immediately sent for Còuttet, who selected from the most trustworthy of the guides, eighteen for us; and six more, after seeing the preparation of eatables and drinkables the landlord had prepared for our journey, volunteered to accompany us, for the privilege of free access to our haversacks. Every thing being arranged the night previous, we breakfasted the following morning, July 15th, at 4 o'clock. The hotel presented at this early hour a lively scene, while the guides were depositing in the different haversacks the provisions which had been prepared, and which were truly in amount enormous for the time we anticipated being absent.

One hour later and we were already skirting the base of the mountain, myself and two friends on mules; and in this way we proceeded, till we entered the thick growth of pines that clothes the mountain side, through which we wound our way, until the broken fragments of rocks and the trunks of fallen trees prevented the further progress of the mules, when we dismounted and sent them back, while we proceeded on foot through the pines, which now becoming less and less thrifty, soon ceased altogether, and nothing but the barren rocks, with only here and there a scraggy shrub, till about 9 o'clock we arrived at the point of perpetual snow, where we halted to take a second *dejeuner a la fourchette*, (breakfast.)

It was at this point we determined to enter upon the Glacier des Bossons, and crossing it, to ascend the mount on the opposite side, which would, we conceived, be easier and less dangerous than continuing our course up the glacier to the Grandes Mulets, which was the point we wished to gain as a resting place for the night.

Here I made an experiment to test the diurnal advance of the glacier. I took three large blocks of stone, with the smoothest faces I could find, and having placed them in a straight line about ten feet distant from each other, I sighted (in the usual manner of farmers in setting a post and rail fence) along the smooth faces of the stones which were turned towards the summit of the mountain. I then had three other stones carried on the glacier at the distance of fifty to sixty feet from each other, and placed in a straight line with the three former stones, and left them to mark the change which should take place in their relative positions, on my return.

A similar experiment I made in the evening on my arrival at the Grand Mulets, and on my return to the Grand Mulets the next day at 1 o'clock, P. M., and at the point where I had made the first experiment at 4 o'clock, P. M., which made nineteen hours for the former, and thirty one for the latter. The stones on the glacier had descended during this time, from a line drawn from the upper surface of the stones on the mountain to the upper surface of the stones on the glacier, between twelve and thirteen inches for the former, and about twenty one inches for the latter, which is about sixteen inches for the twenty four hours.

The number of pulsations and respirations per minute, of the whole party, I had taken at Chamonix, previous to leaving, and found that the average was seventy six of the former and sixteen and a half of the latter. At this point, the perpetual snow line, there was a slight acceleration, the respirations being eighteen and the pulsations eighty two per minute, after resting fifteen minutes, and of course previous to eating, as the pulsations are augmented during the process of digestion.

At 10 o'clock, A. M. we entered upon the glacier; the travelling was at first neither difficult nor fatiguing, for we had each a well tried Alpenstock, which was equal to a third foot in case of need, and our shoes, made for the occasion, were well armed with square-headed nails throughout the whole extent of heel and sole.

The extreme purity of this glacier is remarked by all as greater than that of either of the other glaciers in the valley of Chamonix, and its crevasses present most perfectly the bluish green, and from that to the deep blue of the gulf water. The crevasses in this glacier are much deeper, wider, and more extensive, than either of the others in this valley; and this is owing probably to its great extent, and to its being one of the most precipitous of the Alps. They vary in width from a few feet to many hundred, and taking their length, including their windings, from a few rods to one or two miles. Their depth has been estimated by De Saussure, for the deepest, at six hundred feet, which has been considered as exaggerated—an opinion in which I should agree, if this depth is given as common; but that there is one, and indeed that there are several, of this depth, below the Grand Plateau, I confidently affirm. One in particular, which I measured with a rude instrument constructed on the spot for the purpose, proved to be between eight and nine hundred feet deep; it was but a short distance from the Grand Mulets. This crevasse, as I should judge, was about one fourth of a mile in width, and seemed to have been formed by the inferior side sliding down to the distance mentioned above as the width of the crevasse, while its superior portion, remaining apparently stationary, (I say apparently, because the whole mass is perpetually moving onward,) had increased in height, by the additions made to it from the falling avalanches, so that the upper side rose more than two hundred feet above the inferior border of the crevasse; consequently, measuring its depth from the highest point of its upper edge, it measured near nine hundred feet, while from the highest point of its inferior border, my instrument marked something less than six hundred feet. This I give as the maximum of depth of any crevasse which we observed in this ascent. The crevasses are however, generally, from a few feet to fifty or sixty deep. Many have their sides nearly perpendicular, but in the deeper ones they are always zigzag, and many of the deepest, when they are very wide, may be descended with but little risk by means of ropes and hatchets, which are a necessary accompaniment to these expeditions. The crevasses which are the most difficult and dangerous to cross, are those whose width is about sixty or eighty feet, and eighty or one hundred deep. These frequently extend to a great length, and to avoid the fatigue attendant on following them parallel to their length, an attempt is sometimes made to pass on the bridges, which have been formed by avalanches falling across them, and thus wedging in immense blocks, forming in many places a rude but substantial arch, which rises some ten or twenty feet above their borders, and as many wide, making a very safe and convenient passage, while others at their base are sufficiently wide to tread on with perfect ease and safety. At the apex of the arch, they become so narrow, by melting, that it is quite impossible to stand erect upon their summit; it being only a few inches wide, and sloped on either side like a saddle, one is obliged for a few feet to sit astride of them as on horseback, and trust to the steadiness of his nerves and the firm grasp of his knees, to accomplish a safe transit. The ascent of these bridges is much easier and less hazardous than the descent, in consequence of being compelled, while descending, to look continually into the gap of the depth below, exhibiting the precariousness of the position.

We traversed these seas of ice and snow from about 10 o'clock, A. M. till between 5 and 6 o'clock, P. M. when we arrived at the Grand Mulets, which we should have reached at least two hours sooner, had it not been for a newly formed crevasse of very great extent; (I say *newly formed*, because my guides said that the year previous when they made the ascent to the Grand Mulets it did not exist.) It was of various width throughout its length, from fifty feet to one fourth of a mile; and in following along its side we were obliged to ascend about one thousand feet above the Grand Mulets before we could find a place to cross it, being about two thirds up the length of the crevasse, where turning abruptly, at nearly a right angle, it was filled for the distance of two hundred feet or more by avalanches, which had fallen from the Grand Plateau, or summit of the mount, and illustrated in the grandest and most impressive manner, the way in which gravity hurls down and piles up these immense masses of snow and ice to the height of hundreds of feet, and so equally poised upon pedestals of ice, that have been wasted by the heat of the sun, till it seems impossible that they could bear the enormous superimposed weight. In crossing the chasm at this point, we passed under these shelving masses, some of which projected one hundred feet over our path. The scene was one of wild magnificence; and it was at this point that our guides enjoined the strictest silence, and to tread with the utmost lightness and precaution, which injunction I regarded at the time as being merely an attempt *ad captandum*, in order to enhance in our estimation the value of their services. Being excessively fatigued, and being here screened from the wind and dazzling rays of the sun, I proposed to halt and rest, to which my guide in the most peremptory and positive manner objected, saying if I attempted to stop at this point, he should be obliged to take me up and carry me from underneath this shelving ice, while at the same time, pointing to the water which was dripping slowly from its summit, and trickling down its side and base, he said it would not stand another day's sun, and any cause which should produce a slight vibration of the air, would dislodge other masses above it, which were less firmly fixed than even this one, and they would set the whole mass to tumbling headlong down. This being spoken with so much earnestness, and in a mere whisper, I proceeded. Our *valet de place*, whom we had taken with us, was immediately before me, and being rather awkward, moved very slowly, and had already made one or two false steps, which my guide seeing, advanced at once and stopped him, then told me to pass him, as a few more such steps might set some of the smaller blocks in motion, and as we were behind, we should lose our lives, by his stupidity. I passed him, and a few minutes' walk carried us to the opposite side of this dangerous pass, where we sat down to rest and viewed from a point of safety the danger which we had almost unconsciously braved. It was now frightful to see other promontories of ice, which while we were crossing had been hidden from our view, resting upon mere feathery edges, with sheets of snow dropping over their edges in festoons, appearing scarcely thick enough to support their own weight.

Our guides told us we could now prove, or rather test, the truth of their assertions respecting the powerful effect of the vibration of the air at this height, which hint we at once availed ourselves of, by ordering the whole company to give three shouts, at the height of their voices, which they did, and the effect of which was quickly visible. The first shout produced no sensible movement, but with the second, though the sound produced none of that sharp echo, which we often hear in the gorges of the mountain valleys, yet its effect was manifest, first upon those festooned edges of snow which I have mentioned above, and which with another loud shout began to detach themselves in quick succession, falling in considerable sheets, till one of no great size fell some eighty feet, upon one of those huge rocks of ice, which was poised so equally that it required but the slightest force to turn the balance, when this slid from its resting place, with but little velocity, not as fast apparently as a man would walk; but the momentum of so large a mass must have been enormous. I should judge its slide was not more than twelve or fifteen feet (though it may have been many more) when being suddenly checked, by its base coming in contact with another mass, the momentum it had acquired in its slide threw its summit beyond the centre of gravity, and it pitched headlong down the broken plane of the crevice, which was followed by an active scene of wild and terrific confusion. Avalanche succeeded avalanche of enormous size, as the fall of one detached others larger than itself.

At first their motion was slow and regular, as they merely slid from their resting places, till arrested by another mass, when they came tumbling, rolling, and bounding down as their velocity increased, till no barrier could check their impetuous course.

At their onset, each could be distinctly seen, and marked amid the rest, till by their increased velocity, according to the obstacles they encountered as they rolled onward in their descent, bounding from crag to crag with resistless force, they would rend and shiver themselves and opposing obstacles into immense masses. They seemed to gain additional power from each opposing barrier, till opposer and opposed, rent into ten thousand fragments, rushed headlong, tearing, crashing, thundering down, as if possessing within themselves the elements of life; then deviating from side to side, as any solid angular inclination turned them from their forward course, till ground and broken into myriads of pieces, their forms became too indistinct to be any longer discerned. They then assumed the confused appearance of a circumscribed storm of thick hail and snow, driven madly onward by a furious tempest, until it reached its final resting place, far down in the rough and jagged bosom of the glacier, of which it now forms a part, to be carried slowly yet surely to the valley, and there being liquefied by the rays of a summer sun, to aid in swelling the torrent of the Arve. This mountain river, as if exulting in being loosed from its icy bondage, then leaps joyously along, till it mingles its waters with the deep blue sea—although mingled, yet it is not lost, for it may again assume another and a lighter form, as in vapor it rises from the tranquil bosom of the Mediterranean, a part to be wafted by the soft zephyrs of Italy to irrigate her fertile plains, while the rest may be again transported to clothe anew the lofty summit of some snow-capped Alp.

Those travellers who from the valley of Chamonix have seen these masses of ice falling from the summit of Mont Blanc, on the Grand Plateau, in consequence of their distance and great height, can form no idea of their size. These blocks of ice, which from the valley appear, as they are displaced, not larger than fifteen or twenty feet square, are, to those who are in their immediate vicinity, from one hundred to two hundred feet. This kind of avalanche differs from the Staub-laminen, (dust avalanche,) as they are called by the natives of the Alps, which being formed by the loose fresh-fallen snow of winter, before it has been melted and made compact, is piled up by the whirlwinds which are common in the Alps; such avalanches increase as they descend, till they acquire an enormous size, covering acres, I may say miles, in their descent; overwhelming and laying prostrate whole forests of pines or villages which lie in their course. Another kind, the Grund-laminen, fall chiefly during the early months of spring and summer, as in May and June, when the rays of the sun being very powerful, the snow becomes more compact. They are composed of soggy snow and ice, and are also very destructive.

They were avalanches of this kind, that in 1720, in Ober Gestelen, (Vallais,) and in 1749 in the Tavetsch, produced such devastation. The records of the valleys of the Alps abound with mournful exemplification of the destructive power of these avalanches, and of many others of this class. The wind of the avalanche, whose violent effects have been described by writers, probably acts only by its vibratory power, and the concussion consequent upon the movement of the avalanche, thus filling up the momentary vacuum produced by its rapid motion through the air. This idea of the wind of avalanches is common among the inhabitants of the Alps, as is a similar one among many of us, concerning the wind of a cannon ball, killing without touching.*

In support of their opinions of the wind of avalanches, they cite the fact of large and sturdy pines being cut smoothly off, without the bark or branches being chafed, but I saw nothing of this kind, which could not be accounted for by the rush of wind to fill the vacuum. It was in this way that the village of Ronda in the Visp-Thol, had many of its houses prostrated and scattered in fragments in 1720, and also one of the spires of the convent of Dissentis fell by the vibratory action of the air, produced by an avalanche which fell about one fourth of a mile distant from it. This concussion of the air is familiar to all by the effects produced

* See however an indubitable instance of this effect in Col. Trumbull's Autobiography, p. 21.—*Eds.*

in the discharge of ordnance, near our dwellings. It may be more perfectly exemplified, by taking a bottle and corking it tightly, and discharging at a short distance, twenty or thirty feet, a musket or a rifle, so that the ball shall pass about one inch over the cork; the velocity of the projected bullet produces a vacuum, and the cork leaps from its place of confinement, in consequence of the atmospheric pressure being thus suddenly removed, and by the expansion of the air within the bottle.

The Grand Mulets are two rocks which project from the Glacier des Bossons, whose summits are so pointed, and their sides so perpendicular, that the snow does not rest upon them. Here we halted for the night.

They had loaded a cannon in the valley previous to our departure, and were to discharge it when they saw us (through their telescope) arrive at this point, (Grand Mulets,) which they did, but neither myself nor the guides heard the report, although some of our guides said they saw the smoke.

I had taken up with me six old pigeons, the strongest and shyest I could find in the pigeon-house of the hotel, and now determined to let two of them off from the rock; the time being marked on a small piece of parchment, and attached by a string to one leg. I had desired the landlord to note the time when the pigeons made their appearance at Chamonix. I then tossed one of them a few feet in the air, that he might see to take his direction, when to my surprise, he fluttered a little, and came down nearly as rapidly as I had thrown him up. When we then attempted to catch him, he endeavored to fly, but being unable to rise, he fluttered about, ran with his wings extended a few yards, and was easily taken. I presumed he might have been injured by the confinement in the basket, and so I made the same experiment with three others, the result being the same; proving that the rarity of the air was too great to admit of their supporting themselves. But the next day in descending we let them off about half way down between the Grand Mulets and the upper point of vegetation, and they took their courses directly for Chamonix, and were doubtless safely at home long before we reached the perpetual snow line.

After resting here twenty minutes, and previous to eating, the average pulsations and respirations of the whole party stood at one hundred and twenty eight of the former and thirty of the latter per minute. Notwithstanding the increase in the frequency of the respiratory action was much greater than natural, and increases as you ascend to the higher points of the mountain, I found none of those urgent symptoms mentioned by tourists, of difficult and laborious respiration, that is, during rest or repose, but even at this point, I found that the muscles became rapidly fatigued, and while in motion the respiration was accelerated, and consequently more or less difficult, but ceased to be oppressive after a few moments of rest, proving that the effect was due not to the rarity of the air, but the exercise in this rare atmosphere. The higher you ascend, the greater and greater is the inclination to rest and lassitude, and the power of muscular endurance is diminished almost to zero. The moment however, you place yourself in the horizontal position, by lying on the snow, the muscles being at rest, you feel merely lassitude, but no fatigue, which returns almost immediately, on the muscles being again called into action. The most troublesome and annoying circumstance was the intense thirst, produced in part by the cutaneous transpiration, which was very abundant, in consequence of the fatigue produced by motion, and also by the peculiar condition of the atmosphere. As this thirst increases, the desire for food diminishes, until it becomes actually a loathing. This was experienced not only by myself, but to a great degree even by the guides, who at the Grand Mulets devoured the fattest kind of roasted and boiled meats with the greatest *goût*, but at the Grand Plateau cared for nothing more than the wing of a chicken, refusing positively the hearty meats, but swallowed with infinite satisfaction the Bordeaux wine which I had carried for my own use. The only beverage that had an agreeable taste to me, and which alleviated my thirst, was the *lemonade gazeuse.* Taking a small quantity of snow in my hand, I would saturate it with this liquid, and then allow it to dissolve in my mouth.

My two friends and myself chose the highest point of the Grand Mulets as our resting place for the night; but owing to its steepness, fearing lest we might, during sound sleep subsequent to the fatigue of the day, roll or slide down its side, we constructed with the loose stones from the crevices of the rock, a wall about ten feet long, and about two feet high in the centre, and descending to one foot at its extremities, of a semilunar form, against which we were to place our feet. The larger stones were now removed, to make the foundations of our beds as smooth as the circumstances of the place would permit; we selected each one his place, and spread upon it his sheepskin, while a knapsack served the purpose of a pillow. I had just wrapped my blanket around me, as the sun was sinking below the horizon, throwing its lurid glare upon the snow-capped summits, which now above, below, and on either side, rose in close proximity, presenting a scene in which were mingled the beautiful, and sublime, and more than repaying any lover of nature for the fatigues endured in obtaining the sight. I now prepared for sleep, but the novelty of the position, the deathlike stillness, and the events of the day crowding before my imagination precluded sleep, while the vast expanse of the blue arch of heaven, which was my canopy, studded with its myriads of scintillating lights, invited contemplation rather than repose.

I was not allowed long to enjoy this scene of tranquillity and silence, for the day had been one of excessive heat, and its effects began to be manifested by the fall of avalanches. Situated as the Grand Mulets are, about ten thousand feet above the level of the sea, below the Grand Plateau, at two thirds of the height of Mont Blanc, within two thousand five hundred feet of the summit of the Aiguille de Midi, and projecting from the middle of the glacier, they stand as opponents to very many of the avalanches that fall from either of these elevated points. I had not lain more than twenty minutes, when I was aroused by a tremendous crash, while the entire rock still vibrated from the concussion of the ponderous mass: as I sprang to my feet, and looked over the mountain side, by the light of the moon, which had just risen, making every object, though enlarged and softened, almost as distinct as noonday, this mass of snow and ice could be seen hurrying and rushing headlong in its course, till ground and broken by its own violence it settled down still and tranquil, thousands of feet below, amid the ever moving glacier. They continued to fall for about one hour; at first the interval between was some ten minutes, then more frequently, till becoming less frequent, they ceased altogether, and universal stillness reigned once more, broken only now and then, by what is termed the groanings of the Alps, which is the cracking of the ice among the glaciers.

The fall of the avalanches at this hour is caused by the effect of the sun, (melting the ice,) and at this high point it requires the whole force of the sun's rays during the entire day; the water thus produced runs down and forms pools about their base, which continues to melt there for some time after the sun has set, when one avalanche after another is dislodged, and beginning to fall, they continue till the water again congeals, which prevents any further descent until the following evening, when the same effect being again produced during the day by the same cause, their fall is again renewed. ` I once more prepared myself for sleep, but feeling no inclination that way, I amused myself in watching the constellations, which being immediately over me, were shining with peculiar brightness, and during the course of an hour or more that I was thus engaged, I observed slight flashes of light passing before my eyes, not unlike aurora borealis; and supposed it an optical illusion, probably caused by the glare from the sun and snow to which my eyes had been exposed during the day; but as they became more frequent, I satisfied myself that they were real. Rising and looking down in the direction of Chamonix, I discovered at once the cause, which was a thunder shower in the valley. The *sillons* [streaks] of electricity presented a beautiful sight, as they sported amid the dense clouds that overhung the village. There was none of that dazzling brightness presented by the lightning seen when below the cloud, but merely the red zigzag or forked lines, owing doubtless to the cloud being between us and the electric fluid. Although the lightning could be distinctly seen, we could not detect the slightest sound of thunder; whether this was caused by any peculiar condition of the atmosphere at the time, or by the rareness of the air, or our distance, or whether it is a constant phenomenon here, I am unable to say. There was however, much thunder in the valley, and some very heavy explosions too, I was informed by the landlord on my return the next day.

We left the Grand Mulets between 2 and 3 o'clock, A. M., and and arrived at the Grand Plateau between 8 and 9 o'clock. The view from this elevated point is almost boundless, and the whole extent of country for miles on every side (except that portion where the prospect is interrupted by the summit of Mont Blanc) extended itself far and wide, presenting its plains, mountains and lakes, as distinctly as if spread out upon a map before the eye. The Plateau is an almost level plain, with an area I should judge, of ten acres. The Roches Rouges are between this point and the summit. The clouds began very soon to rise from different points, and often obstructed view after view, so that to continue the ascent to the very summit, we deemed would be useless, as far as the prospect was concerned. This was now nearly or completely limited by the moving masses of cloud and vapor, as they rose from the valleys or hung pendulous on the mountain side; for a moment they were stationary, and then rising in undulating broken lines, they assumed a deeper and denser form, as expanding and spreading themselves through and beyond the various mountain passes, they extended as far as the eye could discern. They formed one great tumultuous ocean of clouds, whose ever restless waves were driven impetuously along, lashing the mountain tops that still peered above their ragged surfaces, and which soon sank in the bosom of the rising vapor, till this vast, restless, rolling cloud, seemed to fill immensity.

We now hastened our descent, which was quickly and easily achieved in comparison with the toil of the ascent; as, in a few minutes, we slid down the snowy plains, which had taken hours of indefatigable effort to surmount. This was done by sitting on the summit of the plane to be descended, with the legs extended in front; then thrusting the Alpenstock in the snow a couple of feet, we depended upon a firm pressure on it to govern the velocity of the descent. Thus, continually repeating this novel kind of locomotion among the inclined snow plains, walking and leaping among the glaciers, jumping and scrambling among the rocks and pines, we arrived again safely at the hotel in Chamonix at about 8 o'clock in the evening, having been absent about forty hours.

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ART. IX.—*Notice of Remains of Megatherium, Mastodon and Silurian Fossils;* in a letter to the Senior Editor, from RUFUS HAYMOND, M. D., dated Brookville, Indiana, Sept. 16, 1843.

*Dear Sir*—Facts, which in themselves seem trifling, and but little likely to benefit science, separately considered, often become of much importance when viewed collectively and in reference to each other. This consideration has induced me to give you some account of a single molar tooth, probably of the Megatherium, now in my possession, and which was found in this (Franklin) county, about fifteen miles west of this village, in latitude *about** 39° 27′ N. and longitude from Washington *about* 8° W.

I am not aware, that any remains of the Megatherium have before been discovered in this country north of Georgia and Virginia.† The tooth was found in the gravelly bank of Salt Creek, a tributary of Whitewater River, which flows into the Great Miami River near its junction with the Ohio. It was uncovered by a freshet, which had washed away the *alluvial* bank so as to expose the tooth to view.

*Dimensions.*—Length, 13 inches; greatest depth, 6 inches; width of grinding surface, 3⅛ inches; length of grinding surface, 6 inches; width at the bottom of socket, 3 inches.

Its weight is now eleven pounds and four ounces; when first found, and previous to being dried, it weighed fourteen pounds. Seven inches of the face or crown of the tooth, had not grown or protruded beyond the *gum* or jaw, so that but six inches had, at the death of the animal, ever been used in mastication. Whether the remaining seven inches would have grown longer, or whether this tooth belonged to the front or the back part of the jaw and was naturally imperfect in *this respect*, I am unable to determine. From front to rear, it has considerable lateral curvature, diverging at the centre, one inch from a right line.

The "*crusta petrosa*" still possesses considerable hardness, but in many places has scaled off. Those "*wedges*" as Dr. Buckland calls them, which had not appeared above the jaw, upon the outside of the tooth, have much the appearance of ribs in a skeleton, not being so thickly covered with the "*crusta*" as the rest of the tooth. The lower ends of the "wedges" or fangs stand separate from each other about half an inch, and form transverse rows of rounded flattish points or partitions finished off with ivory, and exceedingly smooth and highly polished, except those which have not grown beyond the jaw, these being hollow at the ends and bringing to view the enamel of the "*wedge.*" The tooth is not so deep at the ends as in the middle, the ends of the roots forming nearly a segment of a circle. The parts of those "wedges" which had not finished their growth, present nearly sharp points of enamel, each wedge branching and forming three sev-

* Not accurately ascertained, but estimated by the maps and the distance from Cincinnati.

† The Bridgewater Treatise and Hitchcock's Geology are the only authorities at hand.

eral points, which after having been used some time, wear off below the branches and leave but a single transverse cutting edge. This tooth is four inches longer than those described by Dr. Buckland.* This and a part of a tusk, the fragment of a molar tooth, with a few pieces of bones, referable to the Mastodon, are all the fossils of this kind, which to my knowledge, have been found in this part of the country.

It may not be amiss to say a few words in relation to our position in a geological point of view. This and several of the adjoining counties, and indeed a considerable portion of the eastern side of this state, and the western part of the state of Ohio, belong to that formation or group, called by some geologists the Silurian. From the nature of the country, which in its *general* features is almost a level plain, it is impossible to examine the rocks to a greater depth than four hundred and fifty or five hundred feet. The valleys and ravines seem to have been wholly formed by the streams which pass through them, for the various strata upon either side of *all* of them, are opposite to each other and nearly horizontal, showing that they were deposited in the situation which they now occupy in seas or oceans comparatively calm, and that they have never been disturbed, except by the gradual wearing of these streams, since their deposition upon each other. The sides of the hills, or more properly the sides of the valleys, are composed of thin strata of limestone varying from half an inch to two feet, and in some rare instances, many feet in thickness, alternating with clay and clay slates of various thickness, and each of these strata throughout the whole group abound, indiscriminately, with innumerable organic remains. Amongst the most numerous may be reckoned the Terebratula, Producta, Cyathophyllum, Orthoceratite, Paradoxoides Tessini, Spirifer, trilobites, (rare,) corals and corallines without number, moniliform encrinites, pentacrinites, &c. &c., and a single species of spiral univalve shell, but so imperfect that I have not been able to determine its name or place.

Spread all over the country, we have erratic blocks or boulders, consisting of almost every species of primary rocks, but principally granite and granitic gneiss. These are the principal evidences of drift which we have in this neighborhood, having discovered no moraines which are so common in your section of the Union, according to Dr. Hitchcock.

* Bridgewater Treatise, Vol. I, p. 119.

Art. X.—*Notice of a Memoir by C. G. Ehrenberg, "On the Extent and Influence of Microscopic Life in North and South America."**

This important memoir by the illustrious Ehrenberg, is characterized like all the preceding works of this author, not only by marks of the most accurate research and indefatigable industry, but by the still higher merit of far-reaching philosophical views, and a just appreciation of the important bearings and applications of the facts which he has brought to light.

Believing that this memoir is one of peculiar interest to American science, we have endeavored to give in the following pages as correct a view of its contents as is in our power.

The work is divided into the following seven parts, which we intend to notice in order. 1. Introduction. 2. Review of the materials. 3. Enumeration of the American forms, according to the dates of observation. 4. Alphabetical review of all the observed and peculiar forms. 5. Characteristics of the new genera and species. 6. General results of these observations. 7. Explanation of the plates.

I. *Introduction.*—In the commencement, Ehrenberg remarks that microscopic life no longer belongs to the domain of systematic zoology alone, but that its decided influence upon the inanimate nature which every where surrounds and influences us, and upon the fundamental notions of life itself, have of late been recognized, so that the subject is no longer considered merely with regard to its organic and physiological bearings, but for its relations to the inorganic masses of the earth. There are many, however, who still wish to banish these investigations from the circle of strict science, and who wonder that any one should devote so much labor to the strict examination of such inaccessible and remote objects. These prejudices are compared to those which prevented the importance of the first noticed electric and magnetic phenomena from being appreciated, and which long

* Verbreitung und Einfluss des Mikroskopischen Lebens in Süd und Nord Amerika, Ein Vortrag von C. G. Ehrenberg. Gelesen in der Königl. Preuss. Akademie der Wissenschaften zu Berlin, am 25 März und 10 Juni, 1841, mit spätern Zusätzen. Nebst 4 coloriten Kupfertabeln. Berlin, 1843.

left them as mere subjects of amusement, although at present regular professors of electricity and magnetism are established at all the universities of the civilized world.

The author hopes that the continuation of his labors will show, that however much that is untenable may have been presented in science of late, the objects and results of microscopic research are by no means such as to prevent the strictest critical examination, and that they can even be subjected to the best of all tests, ocular demonstration.

He then alludes to his discoveries with regard to the important influence which animalcules have had in filling up streams and harbors, and in the formation of deltas, and states that observations have now rendered it more obvious how rock-masses which are wholly or partially crystalline, may have resulted from the solution and change of minute siliceous and calcareous organisms.

II. *Review of the materials.*—The author in consequence of the various relations of microscopic life to the great field of nature, felt induced to compare the facts observed in Europe with the conditions of other parts of the world, and, accidentally, the American forms were the first examined. Among the materials for this study of the American forms, were specimens of edible clay from the banks of the Amazon, furnished by Von Martius; species collected in a living state in Mexico by the author's brother, Carl von Ehrenberg; earth attached to plants in herbaria; and "a whole box full" of fossil animalcules sent from the United States by Mr. B. Silliman, junior; by Professors Silliman, Hitchcock and Bailey; and a number of the living species of West Point were received directly from Prof. Bailey in the year 1842.

From the results of the investigation of these materials, Ehrenberg is enabled to present a view of the minutest forms of animal life, extending from the Falkland Islands on the south, to Labrador, Kotzebue's Sound, Iceland and Spitzbergen on the north.

III. *Enumeration of the American forms, according to the date of observation.*—This detailed enumeration of species from different localities is full of interest, but our limits compel us to give but brief notices of many of the localities, and to confine our attention chiefly to the most important observations concerning the localities in the United States. We remark however that among the species detected with sea Confervæ from the *Falkland*

*Islands* are several species which have also been found recently in mud from Boston harbor; among the most remarkable of these are Stauroptera aspera, Navicula Lyra, Pinnularia peregrina, &c.

The forms from *Peru* were obtained from Algæ sent to Ehrenberg by the distinguished algologist, Dr. Montagne, and from swamp earth, adhering to a plant in Kunth's herbarium, which was collected in the year 1777. All the genera but one (*Podosira*) are European, and this one has lately been found in Iceland.

In describing the *Brazilian* forms, the author states that in the edible clay of the Amazon, he has detected four species of decidedly fluviatile siliceous infusoria, and seven species of siliceous parts of plants; among the latter is *Amphidiscus rotula*, which also occurs at West Point, N. Y. According to the accounts of trustworthy travellers, the edible infusorial clay of the Amazon, exists as an elevated and wooded plain, forming an extensive stratum, in no way resulting from the present actic . of the Amazon. It is neither the sediment of a swamp, nor a product of the overflowings of the river, but an older deposit, whose age however cannot yet be decided.

In the volcanic mud, called Moya, brought from *Quito* by Humboldt, which is so rich in carbon that it has been used as fuel, Ehrenberg detected ten different species or fragments of organic forms, and proved by microscopic observation that charred parts of plants form a large part of this substance, mingled however with fluviatile siliceous infusoria.

Among the numerous species from *Cuba* we notice Biddulphia pulchella, a truly elegant form, which will probably be found at many places on our sea-coast, as it has been detected near the Pavilion at Rockaway, Long Island.*

The materials from *Mexico*, furnished by Carl von Ehrenberg, were collected at different elevations, from eight thousand five hundred and fifty six feet above the sea, down to the sea itself. Numerous interesting species, not only of siliceous animalcules and parts of plants, but also of soft-shelled infusoria, were found. The most remarkable siliceous infusorial form is the fresh-water species *Terpsinoë musica*, which presents the appearance of a double row of musical notes in a glass casket.

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* See p. 141 of the present volume of this Journal. We have also recently found it, in company with many other beautiful infusorial and Polythalamian forms, in *mud adhering to oysters* dredged at Amboy, New Jersey.

No less than one hundred and twenty forms of siliceous and calcareous animalcules and siliceous parts of plants were detected by Ehrenberg among marine Algæ brought from Vera Cruz by his brother. Among the figures of these forms, we notice fig. 43, plate 3, (*Planularia? Pelagi,*) as strikingly like a fossil Polythalamian shell, abundant in meiocene tertiary of Petersburg, Va.

We pass now to the notice given by Ehrenberg of the localities of the United States, and we regret that our limits will not allow us to insert his account without abridgment.

"The first specimen of the infusoria of the United States which I received, consisted of a portion of the fossil infusoria from West Point, a specimen of which was sent over by Dr. Torrey, and received in 1839. Since that time the richest American materials have been obtained from the United States, where the distinguished native men of science have devoted themselves to the examination of these relations with great zeal and success.

"*Richmond*, *Va.*—A rich booty, consisting of the fossil forms alone of Virginia, has been discovered by the exertions of Prof. W. B. Rogers, the geologist of Virginia. Some of the species have been represented in Prof. Bailey's sketch of American Bacillaria, and he alludes to the apparent resemblance of this geological formation to that of Oran. The strict comparison of these relations possesses now a peculiar geological interest. I have taken the following list of 11 Virginian fossil forms from Prof. Bailey's memoir.

| | *Bailey.* | | *Ehrenberg.* |
|---|---|---|---|
| 1. | Pyxidicula, fig. 2, | = | Pyxidicula cruciata. |
| 2. | Gallionella sulcata, fig. 7, | = | Gallionella sulcata. |
| 3. | Actinocyclus sulcata, fig. 10, | = | Actinoptychus octonarius.* |
| 4. | " " fig. 11, | = | " senarius. |
| 5. | Coscinodiscus lineatus, fig. 12, | = | Coscinodiscus lineatus. |
| 6. | " patina, fig. 13, | = | " minor. |
| 7. | " radiatus, fig. 14, | = | " gigas. |
| 8. | " argus, | = | " argus. |
| 9. | " oculus iridis, | = | " oculus iridis. |

"In the specimens of the tertiary 'infusorial stratum' of Richmond, kindly sent to me through Prof. Bailey from Prof. Rogers, I have, up to this time, observed the following fifty forms, and have compared them directly with the European forms, and also with those from Oran in Africa.

* Under the new genus Actinoptychus are now placed those species of the old genus Actinocyclus which possess internal partitions or folds, while under the old name are retained those in which the external rays are not connected with internal folds.

A. *Siliceous Infusoria.*

| | |
|---|---|
| 1. Actinocyclus quinarius. | 24. Coscinodiscus oculus iridis. |
| 2. " denarius. | 25. " radiatus. |
| 3. " undenarius. | 26. " radiolatus. |
| 4. " duodenarius. | 27. Dictyocha crux. |
| 5. " bioctonarius. | 28. " fibula. |
| 6. Actinoptychus senarius. | 29. " pentasterias. |
| 7. " octonarius. | 30. Eunotia diodon. |
| 8. " duodenarius. | 31. " monodon ? |
| 9. " sedenarius. | 32. Fragillaria amphiceros. |
| 10. " denarius. | 33. " lævis. |
| 11. " vicenarius. | 34. " pinnata. |
| 12. " Jupiter. | 35. Gallionella sulcata. |
| 13. Amphora libyca. | 36. Goniothecium Rogersii. |
| 14. Biddulphia tridentata. | 37. Grammatophora oceanica. |
| 15. Cocconeïs amphiceros. | 38. " undulata ? |
| 16. " leptoceros. | 39. Haliomma —— ? |
| 17. Coscinodiscus argus. | 40. Himantidium Arcus ? |
| 18. " concavus. | 41. Navicula sigma. |
| 19. " limbatus. | 42. Pinnularia peregrina. |
| 20. " lineatus. | 43. Pyxidicula cruciata. |
| 21. " marginatus. | 44. Rhizosolenia Americana. |
| 22. " gigas. | 45. Stauroptera —— ? |
| 23. " minor. | 46. Triceratium obtusum. |

B. *Siliceous parts of Plants.*

| | |
|---|---|
| 47. Spongiolithis acicularis. | 50. Spongiolithis clavus. |
| 48. " caput serpentis. | 51. " fistulosa. |
| 49. " cenocephala. | 52. " fustis. |

"Among these fifty two forms are forty six infusoria, belonging to twenty genera, which genera are all European with the exception of two, *Goniothecium* and *Rhizosolenia*,* which have not been observed

* "GONIOTHECIUM. Genus e familia Bacillariorum, sectione Naviculaceorum. Lorica simplex silicea teres nunquam catenata, strictura media fine utroque subito attenuato, et truncato hinc tanquam anguloso. = *Pyxidicula* media constricta utrinque truncata."

"*G. Rogersii*, articulis lævibus hyalinis."

"RHIZOSOLENIA. Genus e familia Bacillariorum, sectione Naviculaceorum. Characteres *Pyxidiculæ* aut Gallionellæ, loricæ tubulosæ altero fine rotundato clauso, altero attenuato multifido tanquam radiculoso."

"*R. Americana*, testulæ tubulis hyalinis lævibus."

"A curious and very distinct form, whose systematic position is uncertain; only three specimens were seen, all of which were imperfect."

at any other locality. Of the species, ten, or almost one fifth, are new and peculiar.

"Many of the forms occurring in the deposit are, as Prof. Bailey quite correctly concluded from his smaller number of observations, similar to those of Oran, but many of these forms also do *not* occur at Oran. According to the materials now furnished for comparison, the true relations are such, that of the eleven species of the genus Coscinodiscus, five occur at Oran which are also found at Richmond, five are found at Richmond alone, and one at Oran alone. Of thirteen species of Actinocyclus, three agree at both localities, eight occur only at Oran, and two only at Richmond. Of eight species of Actinoptychus, three occur at both places, four in Richmond and one in Oran alone, &c.

"As a considerable number of the species of animals belonging to the chalk formation of Sicily still exist, and consequently cannot be wanting in the tertiary formations, it is evident that no conclusion as to the geological age of these formations can be drawn from the similarity or dissimilarity of these forms.

"This group of American forms is of peculiar interest and scientific importance, because the strata at Richmond are decidedly of marine origin, and consequently give at once a general view of the marine microscopic animals of the North American ocean; for probably the greater number of species are still living there, as they have already been found abundantly on the German coast of the North Sea.* The geological position of the strata must be determined by the order of superposition, the larger included organic remains, &c. as it cannot be decided by means of the infusoria.

"*West Point*, *N. Y.*—The discovery of a bed of fossil infusoria at West Point, N. Y. was announced by Prof. Bailey in the American Journal of Science, Vol. xxxiv, July, 1838; in the year 1839 I received through Humboldt a specimen of this deposit from Dr. Torrey, and in February of the same year I made a report concerning it to the Academy at Berlin. To the fifteen organic forms then mentioned many others have been added by further examination."

Ehrenberg then gives a list of sixty two organic forms detected by him in the fossil specimens from West Point, among which are forty seven independent organisms, (animalcules,) of which only one, *Amphiprora*, belongs to a new genus; all the rest belong to twelve European genera. Only seven species, or about one seventh of the whole, can be considered as peculiar. By far

* Many of these species have been known for some time to exist in a living state, not only upon our sea-coast, but up to the limits of brackish water in many of our rivers.

the greater number appear to agree with European forms. He then continues, thus—

"Besides these fossils, which occur directly under the surface of a peat-bog, and which consequently belong most probably to recent species, I have also had an opportunity to examine a great number of not only recent but still living forms from West Point. Prof. Bailey sent me in the year 1842 some phials full of turf-water from West Point, containing many living species of Bacillaria. These were filled with water at West Point on the 2d of April, 1842, and on the 16th of June I was able to show many of them in a living state at Berlin. I have endeavored to compare all these living or decidedly recent American species with the European, and have consequently drawn figures of all of them. At the same time Prof. Bailey sent me a printed memoir, in which he describes some of the fossil infusoria of Virginia, and a considerable number of recent species from various places in the United States, and particularly from West Point. The following is a list of the species found at West Point, which Prof. Bailey has observed and figured in Parts I and II of his memoir on American Bacillaria."*

As this list furnishes the authentic names of the species figured in this memoir, we give it entire, believing that it will be valuable for reference.

I. Desmidiacea. (See Part I of Bailey's Bacillaria.)

| | | | |
|---|---|---|---|
| Fig. 1. | Desmidium Swartzii ? | = | Desmidium Swartzii. |
| 2, 3. | Euastrum ? | = | " tridens. |
| 4, 5. | " ? | = | " " |
| 6. | " var. | = | " " |
| 7. | " var. | = | Pentasterias radiata ? |
| 8. | " margaritiferum, | = | Euastrum margaritiferum. |
| 9. | " al. sp. | = | Desmidium aculeatum. |
| 10. | " al. sp. | = | Xanthidium fasciculatum. |
| 11. | " al. sp. | = | Arthrodesmus convergens. |
| 12. | " al. sp. | = | " quadricaudatus, p. |
| 13. | " al. sp. | = | Xanthidium bisenarium. |
| 14. | " al. sp. | = | Desmidium glabrum. |
| 15. | Xanthidium al. sp. | = | *Xanthidium arctiscon. |
| 16. | " al. sp. | = | * " coronatum. |
| 17. | Arthrodesmus quadricaudatus, | = | Arthrodesmus quadricaudatus. |
| 18. | " acutus, | = | " acutus. |
| 19. | Micrasterias Tetras, | = | Micrasterias Tetras. |

* This list includes only the species mentioned in Parts I and II of Bailey's American Bacillaria. Part III, including the Echinellæ, and various Spongiolites, Phytolitharia, and Dictyochæ, had not reached Ehrenberg when this list was made out.

| | | | |
|---|---|---|---|
| Fig. 20. | Micrasterias Boryana, | = | Micrasterias Boryana. |
| 21. | " al. sp. | = | " elliptica. |
| 22. | Euastrum Rota, | = | *Euastrum Sol. |
| 23. | " Crux Melitensis, | = | " Crux Melitensis. |
| 24. | " Rota juvenile, | = | " Rota juvenile. |
| 25. | " al. sp. | = * | " Americanum. |
| 26. | " al. sp. | = | " Pecten. |
| 27. | " al. sp. | = | " ansatum. |
| 28. | " al. sp. | = * | " carinatum. |
| 29. | " al. sp. | = | " Crux Melitensis juv? |
| 30. | Closterium lunula, | = | Closterium lunula? turgidum? |
| 31. | " moniliferum, | = | " moniliferum. |
| 32. | " Trabecula, | = | " cremlatum. |
| 33. | " digitus? | = | (Polysolenia Closterium ?) |
| 34. | " lineatum, | = | Closterium turgidum. |
| 35. | " striolatum, | = | " " |
| 36. | " rostratum, | = | " setaceum. |
| 37. | " tenue? | = | " tenue? |
| 38. | " al. sp. | = | " (Trabecula?) |

II. Naviculacea. (See Part II of Bailey's Bacillaria.)

| | | | |
|---|---|---|---|
| Fig. 3. | Gallionella moniliformis, | = | Gallionella moniliformis. |
| 4. | " aurichalcea, | = | " aurichalcea. |
| 5. | " distans, | = | " distans. |
| 6. | " varians, | = | " varians. |
| 7. | " sulcata, | = | " sulcata. |
| 8. | " ? al. sp. | = | *Biddulphia? lævis. |
| 17. | Navicula viridis, | = | Pinnularia viridis. |
| 20. | " al. sp. | = | " Suecica? |
| 21. | ? striatula, | = | Surirella splendida. |
| 23. | Navicula al. sp. | = | *Stauroneis Baileyi. |
| 26. | Eunotia Arcus, | = | Eunotia Westermanni. |
| 28. | " monodon, | = | " monodon. |
| 29. | " diodon, | = | " diodon. |
| 30. | " triodon, | = | " triodon. |
| 31. | " tetraodon, | = | " tetraodon. |
| 32. | " pentodon, | = | " quinaria. |
| 33. | " serra, | = | " decaodon. |
| 35. | Bacillaria paradoxa, | = | Bacillaria paradoxa. |
| 36. | " tabellaris, | } = | Tabellaria trinodis. |
| 37. | " tabellaris adultior, | } | |
| 40. | Fragillaria pectinalis, | = | Himantidium Arcus. |
| 41. | " bipunctata, | = | Fragillaria rhabdosoma. |
| 42. | Meridion vernale, | = | Meridion vernale. |

Many of the species for which Ehrenberg has here furnished the names are new. We take this opportunity to mention that Ehrenberg has been misled by the outline figure 28, and has supposed it to represent a *carinated* Euastrum, which he has consequently named *Euastrum carinatum.* It is *not* carinated. The species fig. 8, Pl. II, which he doubtfully refers to *Biddulphia? lævis*, does not appear to us to belong to Biddulphia. Its cylindrical form and various other characters assimilate it more closely to Gallionella. It also appears allied to Actinocyclus. The species referred to Pinnularia have been separated from the old genus Navicula. We do not think that fig. 29 is a young state of Euastrum Crux Melitensis, as we have seen adult specimens still retaining the usual form. In continuation Ehrenberg remarks:

"Among these fifty three species of infusoria, seven are peculiar, and are indicated by stars. Prof. Bailey's observation of the living dentate species of Eunotia is of particular interest, as they have not as yet been detected in Europe in the living state, although the shells are numerous in the Bergmehl from Sweden and Finland. As I have reason to suspect that some of these forms while living form bands like Fragillaria, and consequently belong to the genus Himantidium, it is particularly desirable that attention should be directed towards them. It is possible that such bands have been confounded with *Fragillaria pectinalis.*"

Ehrenberg then presents a list of sixty nine recent organic forms from West Point, observed by him in a living state at Berlin, and illustrates them by forty five beautiful colored figures. The whole number of independent microscopic organisms known to Ehrenberg as existing at West Point is one hundred and thirty three, belonging to thirty six genera, of which only one (Amphiprora) is extra-European.

*Connecticut.*—In mentioning specimens of fossil infusoria from Connecticut Ehrenberg states, that though sent by B. Silliman, Jr. in 1838, he did not receive them in Berlin until October, 1840, owing to accidental delay in England. He then gives full lists of all the species noticed by him from Andover, New Haven, and Stratford, and erroneously attributes to Prof. Bailey the discovery of these localities.* The most interesting remarks concerning these lists are the following:

* The specimens alluded to were obtained by B. Silliman, Jr. and the late Rev. James H. Linsley.

"The deposit at *Andover* is extremely rich in forms belonging to the genus Trachelomonas, and it may consequently be stated that it is *to a considerable extent formed of loricated monads.*

"The deposit at New Haven is remarkable for the abundance of that exceedingly minute species, the *Staurosira construens*, whose numbers bear a *larger* proportion to the mass, than that of the *Gallionella distans* does in the polishing slate of Bilin."

*Rhode Island.*—Lists of marine species from Providence Cove, and fossil species from the extensive fluviatile deposit discovered by Owen Mason, Esq. in 1838, are given by Ehrenberg, but they include only three new forms.

*Massachusetts.*—Ehrenberg states that the knowledge of the microscopic organisms of Massachusetts has been greatly extended by Prof. Hitchcock, who discovered many deposits of these fossils during his geological survey of that state in the year 1838. Specimens from Andover, Boston, Bridgewater, Pelham, Spencer, and Wrentham, received from Profs. Hitchcock, Silliman, and Bailey, have been examined by Ehrenberg, who gives long lists of the species noticed from each locality, with remarks upon each, from which we select the following.

"From Spencer, in Massachusetts, I received through Prof. Hitchcock large pieces of a very white siliceous marl (Kieselguhr) having the coherence and color of chalk, but much less dense. I am in doubt whether this color is natural or produced by ignition. * * * I might conclude that it resulted from ignition, as this matter has been submitted to chemical analysis by Prof. Hitchcock, but on the other hand it may have been analyzed precisely on account of its whiteness and purity."

The species included in the list for this locality, are all fluviatile except the Polythalamian *Rotalia globulosa*, which being a decidedly marine species, Ehrenberg concludes that the deposit must either be situated near a chalk formation, or else near the sea. We have already stated (in this Journal, Vol. XLIII, p. 394) our belief that some chalk must accidentally have been mingled with Ehrenberg's specimens, as neither the geological nor geographical situation of Spencer is such as Ehrenberg suggests. Neither can we detect any Rotalia in our specimens.

Ehrenberg mentions three kinds of iron ochre, sent by Prof. Hitchcock from Newbury, Bradford, and Marlborough, but he was unable to detect in them *Gallionella ferruginea*, or any other organic forms. If they ever existed in these specimens, he thinks they must have changed into the fine siliceous sand, which is present in these ochres.

*Maine.*—Lists of the fossil infusoria from two different deposits discovered in 1838, near Blue-Hill Pond, in Maine, by Dr. Charles T. Jackson, are given. Both specimens were of a chalky whiteness, and all the forms, with the exception of various Spongiolites, (which are particularly abundant in one sample,) are decidedly fluviatile. Ehrenberg remarks on the difficulty of decision caused by the presence of these apparently marine spiculæ of sponges, and says:

"We may ask, if the formation is marine, why are no Coscinodisci, Actinocycli, &c. to be found? Perhaps it is a deposit from brackish water which in the neighborhood of the sea still contains some species of sponges."

As these Spongiolites suggest similar remarks by Ehrenberg with regard to various localities, we would state, that there can be no doubt that they are certainly of fresh-water origin, although some of them have much resemblance to some marine forms. The circumstances under which they occur in numerous localities, hundreds of miles from the sea, and in the most recent deposits of bogs and streams, leave no doubt of their fluviatile origin.

The notice of the species observed from Newfoundland, Labrador, Kotzebue's Sound, Iceland, and Spitzbergen, we are obliged to omit.

In concluding this enumeration of American localities, Ehrenberg remarks:

"That the extent and influence of the minuter American forms of animal life now known to him does not terminate here. At the above mentioned localities, the forms are chiefly siliceous, but microscopic calcareous organisms have also a most important development in America."

Allusion is then made by the author to the vast extent of the cretaceous formations on the American continent, as shown by Dr. Morton's Synopsis of the Cretaceous Group, and Von Buch's splendid Memoir on the Petrifactions collected by Humboldt in America. Ehrenberg then observes:

"Since the Academy was informed in 1838 that by a peculiar method of observation, it is possible to prove that all writing chalk and many compact calcareous rocks, result from the agglomeration of invisible Polythalamia, this method was applied in 1841 by Prof. Bailey to the cretaceous rocks of North America, and the same results obtained.*

* See this Journal, Vol. XLI, p. 213 and p. 400.

The specimens from Missouri, Mississippi, and New Jersey, sent to me by Prof. Bailey in 1842, for further examination and determination of the forms, have removed all doubts concerning this exceedingly great influence of minute life, which must now be looked upon as a well established scientific fact, and must be attended to in considering the geognostic relations of the earth, and particularly the development of the surface of the earth in all central North America. It would lead too far, to give all the particulars of the rich results lately obtained from these examinations, and as I shall have occasion, in a larger work which is now nearly completed, to present all these details with drawings, comparing all the chalk formations of America, Europe, Asia and Africa, I limit myself to this general notice. But be it remarked, that many of the species of European chalk Polythalamia also occur in Asia, Africa, and America,* while some are wholly local. To the latter belong the *Textilaria Americana*,† whose first and lowest cells are round, while the upper largest cells are always wart-like, longer, and sharper, and at last terminate in a point. This species forms the principal mass of the chalk of the Upper Missouri. Whether flint, or its equivalent, chalk marl with marine infusoria, occurs there, is still unknown, and is very desirable to determine."

Part IV, contains an alphabetical list of all the microscopic American infusoria mentioned in this work, with the localities at which each has been found.

Part V, gives the characteristics of the new genera and species.

Part VI, includes the general results of the examination, viz.

1. There is here presented the first general view of the hitherto unknown character of the surface of the earth, for all zones of the whole continent of America.

2. It proves that not only in situations rich in humus, but also in sandy places of the surface of America, from near the south to near the north pole, there exists an organic life generally invisible to the eye, and that the bottom of the sea is filled with such organic forms.

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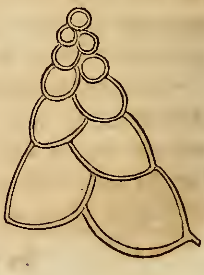
* The identity of some of the American Polythalamia with those of England, Africa, and Asia, was made known by us in this Journal, Vol. XLI, p. 400, and in the Proceedings of the American Association of Geologists and Naturalists, Vol. I, pp. 356-7.



† Ehrenberg gives no figure of this species, but it undoubtedly is the same as that represented in outline in the annexed cut, which we have drawn from the species most abundant in our specimens of the Missouri chalk marl. Outlines of some of the other forms will be found in this Journal, Vol. XLI, p. 400.

3. The whole number of microscopic forms included in this review amounts to six hundred and three, of which four hundred and fifty are Polygastrica, six Rotatoria, eight fragments of plants, (chiefly Phytolitharia,) fifty six Polythalamia, and two other bodies.

4. All of these six hundred and three minute American organisms are included in one hundred and three genera, of which twenty five, or almost one fourth, are new, but seventy nine, or about three fourths, were already known and established. Of these one hundred and three genera, sixty four (including six which are peculiar) belong to the four hundred and fifty Polygastrica. . The six Rotatoria belong to five known genera. The small forms, consisting of parts or fragments of organic bodies, are assembled in eleven genera. The Polythalamia belong to twenty genera, of which five are new and fifteen already known.

Of the four hundred and fifty species of Polygastrica, two hundred and fifty nine, or thirty four more than one half, were hitherto unknown, and about one third are peculiar to America, but two thirds are European. Many of the forms here first named have recently been found in Europe.

In America as in Europe, the genera richest in forms are, Eunotia with forty six species, Navicula and Pinnularia each with forty five species. Then follow in the order of the number of species, the genera Gomphonema twenty one, Cocconeïs nineteen, Stauroneïs eighteen, Fragillaria, Surirella, seventeen.

It is remarkable that all the genera distinguished as peculiar, have presented but few and generally single species.

5. Drawings of three hundred and twenty five American invisible organisms are given, and three hundred and ten are first introduced into the systematic list by short characteristics.

6. These examinations have led to the establishment and systematic review of two hitherto unconsidered great groups or families of microscopic bodies, which indeed are not independent organisms, but have nevertheless the same worth for geological researches, viz. the uncrystalline siliceous bodies arranged under the family name *Phytolitharia*,* and the organized calcareous fragments referred to the family *Zoolitharia*. Like all other species of fossils, these are suited to form a good basis for geological conclusions.

7. The eleven species whose names are given in the following list, distinguish themselves from all others by their distribution, and consequently their influence. They may be considered as cosmopolites, (Weltbürger,) as they are found agreeing in character from the most

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* Various Phytolitharia are represented in this Journal, Vol. XLIII, Pl. 5, figs. 17 to 35, and in Hitchcock's Report on the Geology of Massachusetts, Vol. II, Pl. 20, fig. 29.

southern end of South America to the polar extremity of North America, or through a range of more than 50° south to 60° north latitude.

| | |
|---|---|
| *Cocconeïs placentula. | *Gomphonema clavatum. |
| * " Scutellum. | " minutissimum. |
| *Eunotia amphyoxys. | *Pinnularia viridis. |
| " biceps. | *Stauroptera aspera. |
| " Faba. | *Spongiolithis acicularis. |
| *Fragillaria rhabdosoma. | |

Those distinguished with a * are found agreeing in characters in Central America and in Europe.

8. Six species are distinguished from all the others by the peculiarity of their forms, and are placed under the genera *Climacosphenia*, *Goniothecium*, *Podosira*, *Rhizosolenia*, *Sphenosira* and *Terpsinoë.*

The music animalcule, *Terpsinoë musica*, which resembles a printed sheet of music with twelve notes, standing by sixes in two rows, is remarkably distinct from any European form.

9. In America as in Europe, there occur not merely untraceable, transient, momentary appearances of the minutest forms of life, but also wide-spread fossil strata of their easily recognizable remains, which form earthy and even rocky masses.

10. The only American microscopic organisms which form earth and rocks, are, as in Europe, the siliceous infusoria or the calcareous Polythalamia.

11. There occur in North America (Andover, Wrentham, Mass.) fossil beds of siliceous earth, which are to a considerable extent composed of loricated monads, (Trachelomonas,) and not formed as usual merely of Bacillaria and Phytolitharia. Iron ochre occurs also in Massachusetts, which is very similar to the *Gallionella* deposits.

12. Beds of minute fossil siliceous organisms have been observed of the thickness of fifteen feet at Andover, and twenty eight feet at Richmond. Similar beds occur by the Amazon in South America, and in great extent from Virginia to Labrador.

13. The relations of the invisible calcareous Polythalamia are also the same in America as in Europe ; indeed, the first short examination alone has proved their gigantic development. They may be distinctly recognized as forming the firm earth and the rocks of central North America, as a cretaceous formation from New Jersey to the sources of the Mississippi near the Rocky Mountains.* Even the Andes of the

* Those who are not familiar with American geology should bear in mind that the cretaceous formation only exists as a narrow belt along the Atlantic slope, skirting the older formations which occupy the greater portion of the United States, and that it is chiefly in the far west that it has the gigantic development alluded to by Ehrenberg.

equatorial regions belong to the same chalk formation, and they may consequently be a purely organic product, in a changed condition, produced by the sudden or gradual operation of great volcanic action.

14. There exists in America, (Quito, Massachusetts, Iceland,) as in Europe, combustible earth, serviceable as a kind of peat, which is composed in a great part, even to one third of the mass, of (dead ?) microscopic animalcules, besides the remains of plants.

15. In America (Maine) as in Europe, and still earlier in Asia Minor, a technical application of the infusoria has been made for the purposes of building stone, [bricks,] and for polishing-powder.

16. If, besides considering minute life with regard to its distribution over the surface, we attend also to its extent in depth, or in the mass of the earth, we find it established by careful examinations made by eminent American geologists, that some of the fossil beds of minute siliceous shells belong to the tertiary formation, (Richmond.)

With regard to the forms with microscopic calcareous shells, the researches of the most experienced and careful geologists prove that the often noticed far-extended North American [Polythalamian] limestones, belong to the chalk or secondary formations.*

17. The formation of humus is, in America as in Europe, so dependent upon or accompanied by, invisible independent organic life, that most of those lumps of earth which are overlooked, and which remain adhering to plants when they are cleaned for herbaria, contain preserved whole groups of such organisms.

18. The method of examining the portions of humus from distant parts of the world proves, as the result here presented shows, that one observer, with one and the same instrument, can in a short time make a scientific review and comparison of the invisible minute life of all parts of the earth, and under circumstances the most favorable for scientific examination.

As it is possible to obtain from the plants in herbaria, the smallest materials used in the structure of the earth in all zones, so it is likewise possible, without change of place, to obtain similar results from all parts of the ocean, by examining the matter which adheres to anchors and sounding leads, and the food consumed by various sea animals. The Medusæ and Ascidia in particular are often filled with these forms.

Perhaps there may yet be found in the Coprolites of the transition rocks (Uebergangstein) what has been destroyed during the metamor-

* No infusorial or Polythalamian forms have yet been detected in our Silurian deposits, but they abound in the tertiary and cretaceous group, and we are indebted to Dr. David Dale Owen, of New Harmony, for well characterized Polythalamia from the oolitic portions of the carboniferous (Pentremite) limestone of Indiana.

phosis of the older rocks, as the minutest forms must most easily be destroyed.

19. The opinion of some modern naturalists, that the species of animal organisms by increasing weakness gradually lose the organic constitution, (durch wachsende Schwäche der organischen Constitution aufzehren,) is not confirmed by the smallest forms, either in Europe or America, but on the contrary there occur also in America certain forms which, since a period long anterior to the historic epoch, and in all climates, have perfectly preserved the same characters.

20. The sport of plastic nature, with pleasing changes of form, (mit beliebigem Formen-Wechsel,) does not occur, even with the minutest forms, any where on the western continent, whether at the equator or the poles; but it has been proved that on both hemispheres and from pole to pole, there exists a group of forms which, with characters unchanged from the chalk formation to the present time, have played a great part as similar building-stones in the structure of the surface of the earth.

21. From the rapid and great increase of this knowledge of *an independent deep-working life in the smallest space*, it follows that this field of research cannot be unworthy of the best efforts; and if it is not always equally and quickly productive, or if it may be more agreeable with easier speculation, and rather in poetic sport, than seriously to penetrate into the Remote, yet the only scientific and remunerating method is by slow and sure steps, and under the check of careful and therefore laborious research, to approach the goal which excites the mind of all thinking men of all generations, and will interest all generations yet to come.

Part VII, contains the explanation of the Plates, which are four in number. These are large and beautifully executed, and contain seven hundred figures, including three hundred and twenty five of the *recent* minute organisms from all zones of America. The *fossil* species are omitted on account of their number, but Ehrenberg states that they are already engraved for a larger work, which will soon be published. He also states, that nearly all the figures are drawn from prepared specimens which he still retains as a durable collection which can be employed for unlimited comparisons in future.

In concluding our notice of this valuable paper, we cannot but remark, that although the results already obtained are certainly most important, and although Ehrenberg has made the best possible use of the materials in his possession, yet much remains to be done, (as no one knows better than Ehrenberg himself,) before the whole extent and influence of microscopic life in America can be fully understood and appreciated. Hundreds of species of marine and fluviatile siliceous infusoria, not mentioned in Ehrenberg's list, are known to us, and myriads of the more perishable forms occur in all our waters. The soft and gelatinous forms of these must prevent their being sent across the Atlantic, and it remains for our naturalists to compare them with the European species represented in Ehrenberg's magnificent volume on infusoria. Important information with regard to the infusoria of the United States has already been accumulated by several of our naturalists, among whom we may mention the names of Thomas Cole, Esq. of Salem, and Dr. P. B. Goddard, of Philadelphia, both of whom are accurate and zealous observers.

With regard to our Polythalamian forms, we can state, that they exist at various localities not yet known to Ehrenberg. Besides the numerous living species of our coast, our tertiary formations are filled with characteristic and beautiful forms which we have detected in specimens from various localities, as Petersburg, Va., Wilmington, N. C. We have also found them in marl from near Astoria, Oregon Territory, brought by Mr. James D. Dana, and in carboniferous limestone from Indiana, furnished us by Dr. David Dale Owen. We have gradually accumulated many figures of these forms which we intended for publication, but as Ehrenberg has now undertaken the subject of American Polythalamia, we believe that we cannot do better than to place all our materials in his hands; and as it is desirable to supply him with specimens from as many localities as possible, we take this occasion to invite the friends of science, who may be so situated as to be able to comply with the request, to forward to us specimens of the cretaceous and tertiary deposits of the United States. Specimens from the "rotten limestone" of Florida and Alabama, and from the cretaceous beds of Tennessee, &c. are highly desirable. Even the minute portion which can be sent in a letter will often give most important and valuable results. Specimens of the sediment of our rivers and harbors, particularly from those of the southern regions of the United States, will also be very acceptable.*

* Specimens may be sent addressed to J. W. Bailey, West Point, N. Y., care of Dr. J. R. Chilton, 263 Broadway, New York; or to B. Silliman, Jr., New Haven, Conn.

Art. XI.—*On the Ridges, Elevated Beaches, Inland Cliffs and Boulder Formations of the Canadian Lakes and Valley of St. Lawrence;* by Charles Lyell, Esq., F. G. S., F. R. S., &c.*

After adverting to a former paper on the recession of the Falls of Niagara, and the observations which he made jointly with Mr. Hall in the autumn of 1841, (see Proceed. Geol. Soc. Vol. III, p. 595,) Mr. Lyell gives an account of additional investigations made by him in June, 1842; in the course of which he found a fluviatile deposit similar to that of Goat Island, on the right bank of the Niagara, nearly four miles lower down than the great Falls. The fresh-water strata of sand and gravel here alluded to occur at the Whirlpool. They are horizontal, about forty feet thick, plentifully charged with shells of recent species, and are placed on the verge of the precipice overhanging the river. They are bounded on their inland side by a steep bank of boulder clay, which runs parallel to the course of the Niagara, marking the limit of the original channel of the river before the excavation of the great ravine. Another patch of sand, with fresh-water shells, was detected on the opposite or western side of the river, where the Muddy Run flows in, about one mile and a half above the Whirlpool. From the position of these strata it is inferred that the ancient bed of the river, somewhere below the Whirlpool, must have been three hundred feet higher than the present bed, so as to form a barrier to that body of fresh water, in which the various beds of fluviatile sand and gravel above-mentioned were accumulated. This barrier was removed when the cataract cut its way back to a point further south. The author also remarks, that the manner in which the fresh-water beds of the Whirlpool and Goat Island come into immediate contact with the subjacent Silurian limestone, no drift intervening, shows that the original valley of the Niagara was shaped out of limestone as well as drift. Hence he concludes that the rocks in the rapids above the present Falls had suffered great denudation while yet the Falls were at or below the Whirlpool.

Mr. Lyell thinks that the form of the ledge of rocks at the Devil's Hole, and of the precipice which there projects and faces down the river, proves the Falls to have been once at that point. An ancient gorge, filled with stratified drift, which breaks the continuity of the limestone on the left bank of the Niagara at the Whirlpool, was examined in detail by the author, and found to be connected with the val-

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* Communicated to this Journal by the author, having been previously read before the Geological Society of London, and published in Vol. IV, No. 92, of their Proceedings.

ley of St. David's, about three miles to the northwest. This ancient valley appears to have been about two miles broad at one extremity, where it reaches the great escarpment at St. David's, and between two and three hundred yards wide at the other end, or at the Whirlpool. Its steep sides did not consist of single precipices, as in the ravine of Niagara, but of successive cliffs and ledges. After its denudation the valley appears to have been submerged and filled up with sand, gravel, and boulder clay, three hundred feet thick.

A description is next given of certain modern deposits, containing fresh-water shells, on the western borders of the Niagara, above the Falls, and in Grand Island, in order to show that the future recession of the Falls may expose patches of fluviatile sediment similar to those in and below Goat Island.

The author then passes to the general consideration of the boulder formation on the borders of Lakes Erie and Ontario, and in the valley of the St. Lawrence, as far down as Quebec. Marine shells were observed in this drift at Beauport, below Quebec, as first pointed out by Captain Bayfield, and also near the mouth of the Jacques Cartier river, and at Port Neuf and other places; also at Montreal, where they reach a height probably exceeding five hundred feet above the sea, the summit of Montreal mountain being seven hundred and sixty feet high, according to Bayfield's trigonometrical measurement, and the shells being supposed to be two hundred and forty feet below the summit. These shells, therefore, being more than three hundred feet above Lake Ontario, we may presume that the sea in which the drift was formed extended far over the territery bordering on that lake. The most southern point at which the author saw fossil shells belonging to the same group as those of Quebec was on the western and eastern shores of Lake Champlain, viz. at Port Kent and Burlington, in about lat. 44° 30′. Here, and wherever elsewhere the contact of the drift is seen with hard subjacent rocks, these rocks are smoothed, and furrowed on the surface, in the same manner as beneath the drift in northern Europe. The species of shells occurring in the drift, to which Mr. Lyell has made some additions, are not numerous, and are all, save one, known to exist, but are inhabitants, for the most part, of seas in higher latitudes. Many of them are the same as those occurring fossil at Uddevalla and other places in Scandinavia, and they imply the former prevalence of a colder climate when the drift originated. At Beauport there are large and far-transported boulders, both in beds which overlie and underlie these marine shells.

The author next describes the ridges of sand and gravel surrounding the great lakes, which are regarded by many as upraised beaches. He examined, in company with Mr. Hall, the "Lake ridge," as it is called, on the southern shore of Lake Ontario, and other similar ridges north of Toronto, which were formerly explored by Mr. Roy, (see Proceed. Geol. Soc. Vol. II, p. 537,) and which preserve a general parallelism to each other and to the neighboring coast. Some of these have been traced for more than one hundred miles continuously. They vary in height from ten to seventy feet, are often very narrow at their summit, and from fifty to two hundred yards broad at their base. Cross stratification is very commonly visible in the sand; they usually rest on clay of the boulder formation, and blocks of granite and other rocks from the north are occasionally lodged upon them. They are steeper on the side towards the lakes, and they usually have swamps and ponds on their inland side; they are higher for the most part and of larger dimensions than modern beaches. Several ridges, east and west of Cleveland in Ohio, on the southern shore of Lake Erie, were ascertained to have precisely the same characters. Mr. Lyell compares them all to the osars in Sweden, and conceives that, like them, they are not simply beaches which have been entirely thrown up by the waves above water, but that many of them have had their foundation in banks or bars of sand, such as those observed by Capt. Grey running parallel to the west coast of Australia, lat. 24° S., and by Mr. Darwin off Bahia Blanca and Pernambuco in Brazil, and by Mr. Whittlesey near Cleveland in Lake Erie. They are supposed to have been formed and upraised in succession, and to have become beaches as they emerged, and sometimes cliffs undermined by the waves. The transverse and oblique ramifications of some ridges are referred to the meeting of different currents and do not resemble simple beaches.

The base-lines of the ridges east and west of Cleveland, are not strictly horizontal according to Mr. Whittlesey, but incline five feet and sometimes more in a mile. Those near Toronto are said by Mr. Roy to preserve the same exact level for great distances, but Mr. Lyell does not conceive that our data are as yet sufficiently precise to enable us to determine the levels within a few feet at points distant several hundred miles from each other. No fossil shells have been obtained from these ridges, and the author concludes that most of them were formed beneath the sea or on the margin of marine sounds. Some of the less elevated ridges, however, may be of lacustrine origin, and due to oscillations in the level of the land since the great lakes existed, for unequal movements, analogous to those observed in Scandinavia, may have uplifted fresh-water strata above the barriers which divide Lake Michigan from the basin of the Mississippi, or Lake Erie from Ontario, or the waters of Ontario from the ocean. Considerable differences of level may have been produced in the ancient beds of these vast inland bodies of fresh water, while the modern deposit and the subjacent Silurian strata may to the eye appear perfectly horizontal.

The author then endeavors to trace the series of changes which have taken place in the region of Lakes Erie and Ontario, referring first to a period of emergence when lines of escarpment like that of Queenston, and when valleys like that of St. David's were excavated; secondly, to a period of submergence when those valleys and when the cavities of the present lake-basins were wholly or partially filled up with the marine boulder formation; and lastly, to the re-emergence of the land, during which rise the ridges before alluded to were produced, and the boulder formation partially denuded. He also endeavors to show, how during this last upheaval the different lakes may have been formed in succession, and that a channel of the sea must first have occupied the original valley of the Niagara, which was gradually converted into an estuary and then a river. The great Falls, when they first displayed themselves near Queenston, must have been of moderate height, and receded rapidly, because the limestone overlying the Niagara shale was of slight thickness at its northern termination. On the further retreat of the sea a second fall would be established over lower beds of hard limestone and sandstone previously protected by the water; and finally, a third fall would be caused over the ledge of hard quartzose sandstone which rests on the soft red marl, seen at the base of the river-cliff at Lewiston. These several falls would each recede further back than the other in proportion to the greater lapse of time during which the higher rocks were exposed before the successive emergence of the lower ones. Three falls of this kind are now seen descending, a continuation of the same rocks on the Genesee River at Rochester. Their union, in the case of the Niagara into a single fall, may have been brought about in the manner suggested by Mr. Hall, (Boston Journ. Nat. Hist., 1841,) by the increasing retardation of the highest cataract in proportion as the uppermost limestone thickened in its prolongation southwards, the lower falls meanwhile continuing to recede at an undiminished pace, having the same resistance to overcome as at first.

Mr. Lyell considers the time occupied by the recession of the Falls from the Whirlpool to be quite conjectural, but assigns a foot rather than a yard a year as a more probable estimate; thus he shows the Mastodon, found on the right bank near Goat Island, though associated with shells of recent species, to have claim to a very high antiquity, since it was buried in fluviatile sediment before the Falls had receded above the Whirlpool.

ART. XII.—*On the Tertiary Strata of the Island of Martha's Vineyard in Massachusetts;* by CHARLES LYELL, Esq., V. P. G. S., &c.*

THE most northern limit to which the tertiary strata bordering the Atlantic have been traced in the United States, is in Massachusetts, in Martha's Vineyard, lat. 41° 20′ north, an island about twenty miles in length from east to west, and about ten from north to south, and rising to the height of between two and three hundred feet above the sea. The tertiary strata of this island are, for the most part, deeply buried beneath a mass of drift, in which lie huge erratic blocks of granite and other rocks, which appear to have come from the north, probably from the mountains of New Hampshire. The tertiary strata consist of white and green sands, a conglomerate, white, blue, yellow, and blood-red clays, and black layers of lignite, all inclined at a high angle to the northeast, and in some of their curves quite vertical. They are finely exposed near Chilmark on the southwest side of the island, and in the promontory of Gay Head at its southwestern extremity, where there is a vertical section of more than two hundred feet in height.

Attention was first called to this formation by Prof. Hitchcock in 1823, who appears to be the only American geologist who has examined them personally. He compared the beds at Gay Head to the plastic and London clays of Alum Bay in the Isle of Wight, to which, lithologically, they bear a striking resemblance, consisting in both cases of variously and brightly colored clays and sands with lignite, all incoherent and highly inclined. Various opinions, however, have been put forth as to the relative age of the Martha's Vineyard strata, which were assigned by Prof. Hitchcock, at a time when the tertiary formations of the United States were less known, to the eocene period, while Dr. Morton supposed them to be in part only tertiary, and that they rested on green-sand of the cretaceous period.

The section at Gay Head is continuous for four fifths of a mile; the beds dip to the northeast generally at an angle of from thirty five to fifty degrees, though in some places at seventy degrees. The clays predominate over the sands. In one place Mr. Lyell found a great fold in the beds, in which the same osseous conglomerate and associated beds of white sand, on the whole fifty feet thick, were so bent as to have twice a northeasterly, and once a southwesterly dip. In the yellowish and dark brown clay near the uppermost part of the section at Gay Head, and in the green-sand immediately resting upon it,† Mr Lyell

* From the Proceedings of the London Geological Society, Vol. IV, No. 92.

† Nos. 5 and 6 of Prof. Hitchcock's section.

found the teeth of a shark, that of a seal, vertebræ of Cetacea, crustacean remains, and casts of *Tellina* and *Mya*. These prevail at intervals through a thickness of nearly one hundred feet, and are followed by beds of sand and clay with lignite. Mr. Lyell found no remains in the red clays. Many rolled bones were found in the osseous conglomerate.

In the section at Chilmark similar strata to those at Gay Head occur, but the general dip is southwest. Some of the folds, however, give anticlinal dips to the northeast as well as the southwest, and there are many irregularities, the beds being sometimes vertical and twisted in every direction. Several faults are seen, and veins of iron-sand, which intersect the strata like narrow dykes, as if there had been cracks filled from above. One bed of osseous conglomerate at Chilmark, four yards in thickness, is vertical, and its strike is well seen to be north 25° east, so that the disturbances have evidently been so great that it would be difficult without more sections to determine positively the prevailing strike of these beds. The incumbent drift is very variable in thickness, and large erratics, from twenty to thirty feet in diameter, are seen resting on quartzose sand. The author saw no grounds for concluding that any cretaceous strata occur any where in the island, nor could he find any fossils which appeared to have been washed out of a cretaceous formation into the tertiary strata, as some have suggested.

Mr. Lyell proceeds to the consideration of the organic remains collected by himself in Martha's Vineyard.

*Mammalia.*—1. A tooth, identified by Prof. Owen as the canine tooth of a seal, of which the crown is fractured. It seems nearly allied to the modern *Cystophora proboscidea.*

2. A skull of a walrus, differing from the skulls of the existing species (*Trichecus rosmarus*, Linn.), with which it was compared by Prof. Owen, in having only six molars and two tusks, whereas those of the recent have four molars on each side, besides occasionally a rudimentary one. The front tusk is rounder than that of the recent walrus.

3. Vertebræ of *Cetacea*, some of which are referred by Prof. Owen to the Whalebone whales, and others to the Bottle-nosed (*Hyperoodon*).

*Pisces.*—Teeth of sharks resembling species from the Faluns of Touraine, viz. *Carcharias megaladon*, *Oxyrhina xiphodon*, *O. hastulis*, and *Lamna cuspidata*. With these were large teeth of two species of *Carcharias*, one resembling *C. productus*, a Maltese fossil. With the exception of the two last, Mr. Lyell found the same species in meiocene strata near Evergreen, on the right bank of James River in Virginia.

*Crustacea.*—A species considered by Mr. Adam White as probably belonging to the genus *Cyclograpsus*, or the closely allied *Sesarma* of Say, and another, decidedly a *Gegarcimus*.

*Mollusca.*—1. Casts of a *Tellina* allied to *T. biplicata*, a meiocene fossil, and of another near *T. lusoria*. 2. Cast of a *Cytherea* resembling *C. Sayana*, Conrad. 3. Three casts of a *Mya*, one of which bears close resemblance to *Mya truncata*.

Mr. Lyell concludes, from the various evidence here given, that the strata of Martha's Vineyard are meiocene. The numerous remains of Cetacea of the genera *Balæna* and *Hyperoodon* are adverse to the supposition of their being eocene, while such fossils abound in the meiocene beds of America. The other fossils all point to a similar conclusion.

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Art. XIII.—*On the Geological Position of the Mastodon giganteum and associated Fossil Remains at Bigbone Lick, Kentucky, and other localities in the United States and Canada;* by Charles Lyell, Esq. V. P. G. S. &c.*

With a view to ascertain the relations of the soil in which the bones of the Mastodon are found, to the drift or boulder formation, whether any important geographical or geological changes had taken place since they were imbedded, and what species of shells are associated with them, Mr. Lyell visited a number of places where they had been obtained. In this paper he gives the result of his researches.

The most celebrated locality visited was Bigbone Lick, in the northern part of Kentucky, distant about twenty five miles to the southwest of Cincinnati, situated on a small tributary of the river Ohio called Bigbone Creek, which winds for about seven miles below the Lick before joining the Ohio. A "lick" is a place where saline springs break out, generally among marshes and bogs, to which deer, buffaloes, and other wild animals resort to drink the brackish water and lick the salt in summer. The country around Bigbone Lick, and for a considerable distance on both banks of the Ohio, above and below it, is composed of blue argillaceous limestone and marl, constituting one of the oldest members of the transition or Silurian system. The strata are nearly horizontal and form flat table-lands intersected by numerous valleys in which alluvial gravel and silt occur; but there is no covering of drift in this region. The drift is abundant in the northern parts of Ohio and Indiana, but disappears almost entirely before we reach the Ohio.

Until lately herds of buffaloes were in the habit of frequenting the springs, and the paths made by them are still to be seen. Numbers of these animals have been mired in the bogs, and horses and cows have perished in like manner. Along with their remains are found innumer-

* From the Proceedings of the London Geological Society, Vol. IV, No. 92.

able bones of Mastodon, elephant, and other extinct quadrupeds, which must have visited these springs when the valley was in its present geographical conditon in almost every particular, and which must have been mired in them as existing quadrupeds are at present. The Mastodon remains are most numerous and belong to individuals of all ages. The mud is very deep, black, and soft. In places it is seen to rest upon the limestone, and at some points it swells up to the height of several feet above the general level of the plain and of the river. It is occasionally covered by a deposit of yellow clay or loam, resembling the silt of the Ohio, which is from ten to twenty feet thick, rising to that height above the creek and often terminating abruptly at its edges. This loam has all the appearance of having been deposited tranquilly on the surface of the morass and of having afterwards suffered denudation. The Mastodon and other quadrupeds have been mired before the deposition of the incumbent silt, for a considerable number of fossil bones have been found by digging through it. Accompanying the bones are fresh-water and land shells, most of which have been identified by Mr. Anthony with species now existing in the same region.

Mr. Lyell observes that the surface of the bog is extremely uneven, and accounts for it partly by the unequal distribution of the incumbent alluvium, which presses with a heavy weight on certain parts of the morass, from which other portions of the surface are entirely free. He also attributes it in part to the swelling of the bog where it is fully saturated with water near the springs.

The author is of opinion that the fossil remains of Bigbone Lick are much more modern than the deposition of the drift, which is not present in this district. But although the date of the imbedding of these mammalian fossil remains is so extremely modern, considered geologically, it is impossible to say how many thousand years may not have elapsed since the Mastodon and other lost species became extinct. They have been found at the depth of several feet from the surface, but we have no data for estimating the rate at which the boggy ground has increased in height, nor do we know how often during floods its upper portion has been swept away.

*Ohio.*—The Ohio River immediately above and below Cincinnati is bounded on its right bank by two terraces consisting of sand, gravel and loam, the lower terrace consisting of beds supposed to be much newer than those of the upper. In the gravelly beds of the higher terrace, teeth both of the Mastodon and elephant have been met with. Mr. Lyell was assured that a boulder of gneiss, twelve feet in diameter, was found resting on the upper terrace, about four miles north of Cincinnati, and that some fragments of granite had been found in a similar situation at

Cincinnati itself. These facts show that some large erratics have taken up their present position since the older alluvium of the Ohio valley was deposited. In travelling northwards from Cincinnati towards Cleveland, Mr. Lyell found the northern drift commence in partial patches twenty five miles from the former city and about five miles northeast of Lebanon, after which it continually increased in thickness as he proceeded towards Lake Erie.

*New York: Niagara Falls.*—In a former paper Mr. Lyell alluded to the position of the remains of Mastodon, twelve feet deep, in a fresh-water formation on the right bank of the river Niagara at the Falls. He remarks that if we had not been able to prove that the cataract had receded nearly four miles since the origin of the fluviatile strata in question, we should have been unable to assign any considerable duration of time as having intervened between the inhumation of the Mastodon in marl full of existing shells and the present period. The general covering of drift between Lakes Erie and Ontario is considered to be of much higher antiquity than the gravel containing the bones of the Mastodon at the Falls.

*Rochester.*—In the suburbs of this city remains of the *Mastodon giganteum* were found associated with existing species of Mollusca in gravel and marl below peat.

*Genesee.*—Here remains of the *Mastodon giganteum* were found with existing shells in a small swamp, in a cavity of the boulder formation, so that the animal must have sunk after the period of the drift, when a shallow pond fed by springs was inhabited by the same species of fresh-water Mollusca as now live on the spot.

*Albany and Greene Counties.*—Mr. Lyell examined, in company with Mr. Hall, two swamps west of the Hudson River, where the remains of Mastodon occurred in both places at a depth of four or five feet, precisely in such situation as would yield shell marl, and peat, with remains of existing animals in Scotland. Cattle have recently been mired in these swamps.

According to Mr. Hall the greatest elevation at which Mastodon bones have been found in the United States is at the town of Hinsdale, situated on a tributary of the river Alleghany in Cattaraugus County in the State of New York, where they occur at an elevation of fifteen hundred feet above the level of the sea.

*Maryland.*—In the museum at Baltimore, Mr. Lyell was shown the grinder of a Mastodon, distinct from *M. giganteum*, and which had been recognized and labelled by Mr. Charlesworth as *M. longirostris*, Kaup. It was found at the depth of fifteen feet from the surface in a bed of marl near Greensburg, in Caroline County, Maryland, and is considered by Mr. Lyell as a meiocene fossil.

*Atlantic border.*—Between the Appalachian Mountains and the Atlantic there is a wide extent of nearly horizontal tertiary strata, which at the base of the mountains are five hundred feet and upwards in height, but decline in level nearer the ocean, and at length give place to sandy plains and low islands skirting the coast, in which strata containing marine shells of recent species are met with, slightly elevated above the sea. Occasionally deposits formed in fresh-water swamps occur, below the mean level of the Atlantic or overflowed at high tide. In this district Mr. Nuttall discovered, on the Neuse fifteen miles below Newbern, in North Carolina, a large assemblage of mammalian bones, including those of the *Mastodon giganteum*, resting on a deposit containing marine shells of recent species. Mr. Conrad presented Mr. Lyell with the tooth of a horse covered with barnacles, from this locality. Professor Owen has examined it and could find no corresponding tooth of a recent species, but considers it as agreeing with the horse-tooth brought by Mr. Darwin from the north side of the Plata in Entre Rios, in South America.

*South Carolina.*—Remains of the Mastodon were found in digging the Santee Canal, in a spot where large quadrupeds might now sink into the soft boggy ground.

*Georgia.*—Bones of the Mastodon and Megatherium occur in this district in swamps formed upon a marine sand containing shells of species now inhabiting the neighboring sea.

Mr. Lyell in conclusion offers the following observations :—

1. That the extinct animals of Bigbone Lick and those of the Atlantic border in the Carolinas and in Georgia belong to the same group, the identical species of Mastodon and elephant being in both cases associated with the horse, and while we have the Mylodon and Megatherium in Georgia, the Megalonyx is stated by several authors to have been found at Bigbone Lick.

2. On both sides of the Appalachian chain, the fossil shells, whether land or fresh-water, accompanying the bones of Mastodons, agree with species of Mollusca now inhabiting the same regions.

3. Under similar circumstances Mr. Darwin found the Mastodon and horse in Entre Rios, near the Plata, and the Megatherium, Megalonyx and Mylodon, together with the horse, in Bahia Blanca in Patagonia; these South American remains being shown by their geological position to be of later date than certain marine newer pliocene, and post-pliocene strata. Mr. Darwin also ascertained that some extinct animals of the same group are more modern in Patagonia than the drift with erratics.

4. The extinct quadrupeds before alluded to in the United States lived after the deposition of the northern drift, and consequently the coldness of climate which probably coincided in date with the transportation of the drift, was not as some pretend the cause of their extinction.

ART. XIV.—*On the Parallelogram of Forces;* by ALEXANDER C. TWINING, Professor of Mathematics, Natural Philosophy and Civil Engineering in Middlebury College.

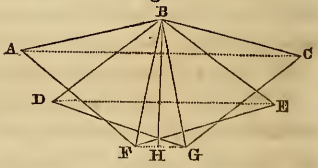
I PROPOSE to treat of the subject in two methods.

*Method first.*

To investigate the intensity and direction of the resultant of any two given forces.

Let BA, BE (fig. 1) represent two equal forces, each of which call unity. Apply two new forces, BD, BC,—each being 1,—in such a manner that ABE, and its equal DBC, may each be a multiple, by $m$, of CBE. Put $\chi$ for the resultant of BC, BE, at the unit angle CBE, which call A. Let R, R′ represent the equal resultants of BA, BE and of BD, BC, which will be, respectively, in the lines BF, BG, bisecting the angles ABE, DBC. Then the four forces BA, BD, BE, BC have the same resultant with the two, R and R′,—which, since FBG=EBC, will be R$\chi$. Then R$\chi$ = Res. (BA, BC)* + Res. (BD, BE). But BA, BC act at the angle $\overline{m+1}$A, and BD, BE act at $\overline{m-1}$A. Therefore to find the resultant, at the angle $\overline{m+1}$A, of two equal forces, we multiply the resultant at $m$A by $\chi$, and deduct the resultant at $\overline{m-1}$A. By assuming the value of $m$, successively, 1, 2, 3, &c. we may find an expression for the resultant of the two equal forces, acting at any multiple of A we choose, in terms of $\chi$ and the values of $m$.

Fig. 1.




Having thus shown the law of formation of the expression for the resultants of unit forces acting at multiples of the unit angle, I shall next exhibit the law of formation of the diagonals of parallelograms under analogous circumstances.

I resume the figure already used. But, instead of representatives of forces, let BA, BE be two sides of a parallelogram, each equal to 1, and having its diagonal BF, which I call D. Let BD, BC, in like manner, have the diagonal BG=D; and let the

* By such expressions as Res. (BA, BC), Diag. (BA, BC), I intend the resultant of BA and BC, or the diagonal pertaining to BA, BC, as two sides of a parallelogram.

included angles ABE, DBC, be, each, a multiple by $m$ of the angle EBC, which I call A′, and which I will suppose to be such as to have the diagonal of EBC, when completed, equal to $\chi$, ($m$ and $\chi$ having the same numerical values as in the former paragraph.) Join FG, DE and AC, which are evidently parallel; and intersect these parallels by BH, which bisects FBG. Since EF and DG equal BA and BC, and intersect at the same angle, it is plain that the part of BH intercepted between the parallels FG and DE equals the part between AC and the point B. But this last is half the diagonal of AB, BC, if completed; and the part of BH between DE and B is half the diagonal of DB, BE, if completed. Doubling, we deduce, therefore, 2BH = diag. (AB, BC) + diag. (DB, BE). But, since FBG=EBC, 2BH=D$\chi$; also AB, BC include the angle $\overline{m+1}$A′, and DB, BE include $\overline{m-1}$A′. We have, therefore, the diagonal pertaining to the sides with the included angle $\overline{m+1}$A′ equal to that with the included angle $m$A′, augmented in the ratio of 1 to $\chi$, diminished by that with the included angle $\overline{m-1}$A′.

The law of formation is the same, therefore, both for resultants and diagonals; so that, if both the forces and the sides of the parallelograms are represented by unity, and the former, acting at the angle A, have a resultant represented in intensity by the diagonal pertaining to the latter, when their included angle is A′, then, also, would the resultant of the same forces, acting at the angle $m$A, be represented by the diagonal pertaining to the sides with the included angle $m$A′. And the converse is evidently true. But whether A=A′ remains to be shown.

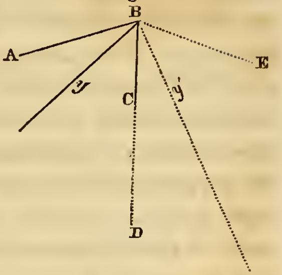
For this purpose, I again resume the figure first used. Let the forces BA, BC—each equal to unity—acting at the given angle ABC, have a resultant represented in value by the diagonal of a parallelogram, whose two adjacent sides DB, BE—each equal to 1—include the unknown angle DBE, less or greater than ABC. Take of ABC an undetermined exact part or measure $z$; also of DBE a like proportional part $z'$. Then, by the converse of the proof already given, it is evident that the two given forces, acting at the angle $z$, would have a resultant represented by the diagonal pertaining to the given sides DB, BE, having the included angle $z'$. Take $nz$, $nz'$, such entire multiples of $z$ and $z'$ that one multiple shall exceed, while the other shall not equal two right angles; which, on the supposition that $z$ and $z'$ have a difference, may evidently be done. Now, by what has been shown, the resultant of the equal forces, acting at the angle $nz$, is represented by the diagonal pertaining to the sides with the included angle $nz'$; and thus—since one of these multiples has a ratio to two right angles of greater inequality, and the other of less—a case is constituted in which it appears that the resultant of two equal forces bisects, not their interior, but their exterior angle; which is absurd. Therefore ABC and DBE cannot differ; and it is made evident that the resultant of any two equal forces is represented, in direction and intensity, by the diagonal of a parallelogram whose sides which include the bisected angle represent, in direction and intensity, the forces.

Let then BA, BE have their resultant BF. Let N represent the entire effect of each, resolved in the direction BF. The only residual effects must be normal to BF, and must destroy each other. Therefore $N+N=DF$, or $N=\frac{DF}{2}=\cos. ABF$, to the radius BA. By the same conclusion the residual effect must equal the cosine of the complement, that is to say, the sine of the same angle. Therefore a force represented, in direction and intensity, by the hypothenuse of a right angled triangle is the resultant of the forces represented, in the same respects, by the other two sides. And from this the law that regulates the resultant of forces acting at any angle whatever is a deduction so obvious that it need not, here, be considered.

*Remark.*—The foregoing method of deriving the diagonal pertaining to multiple angles, from the diagonal at the unit angle, leads, demonstrably, to the equation $2\cos. mA=\chi^m-m\chi^{m-2}+m.\frac{m-3}{2}\chi^{m-4}$, &c. in which A is any given angle, $m$ any given entire number, and $\chi$ twice the cosine of A,—the series being supposed to end with the term in which the exponent of $\chi$ becomes 1, or 0; or, otherwise, to the equation $2\cos. mA=\varphi(m,\chi)+\varphi(-m,\chi)$, in which $\varphi(m,\chi)$ designates the entire series above given, without limit, and $m$ is unlimited in value,—which equations, it is well known, are of signal use in the discussion and treatment of certain circular functions. Another application of the same principle of investigation, not necessary to my subject, but collateral with it, and worthy, it may be, of notice, I subjoin.

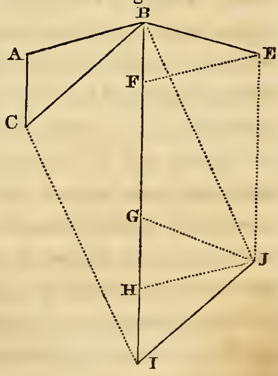
*Problem.* Knowing, in intensity, the resultant of two equal forces, to investigate that of any two forces.

Fig. 2.




Let BA=1, (fig. 2,) be a force, and BC=$a$, another, applied at the angle ABC=A, with the first. Apply two new forces at the equal angle CBE,—namely, BE, BD; and let BE=BA; also let BC : BA : : BE=BA : BD=$\frac{1}{a}$. Call the resultant of BA, BC $y$, and that of BE, BD $y'$. Then we have Res. (BA, BE) + Res. (BC, BD) = Res. $(y, y')$. But, since $y : y' :: a : 1$, the resultant of $y$ and $y'$ is $\frac{y^2}{a}$; and it must lie in the line BD, because it must make the same angle with the force $y'$ that the resultant $y'$ makes with the force BD. We have, then, Res. (BA, BE) + $\left(\frac{1}{a}+a\right) = \frac{y^2}{a}$. But Res. (BA, BE) = 2cos. A. Whence $y=(1+2a\cos. A+a^2)^{\frac{1}{2}}$, which, by trigonometry, equals the third side of a triangle having two sides AB and BC, and their included angle the supplement of A. If we suppose A to be a right angle, our expression reduces to $y=(1+a^2)^{\frac{1}{2}}$, and becomes an independent demonstration of the law that regulates the intensity of a resultant compared with that of its rectangular components.

Fig. 3.




The necessity of the reference to trigonometry, made above, may be obviated by an application, purely geometrical, of the same principle of reasoning, in the following problem.

*Prob.* To find one side of a triangle from the other two sides which include a given angle.

Let BA, AC (fig. 3) be two given sides which include a given angle BAC. Draw BI parallel to AC; also BE equal to BA, at the angle EBI equal to ABI. Take BG in BI, having to BE the ratio of BA to AC. Complete EBGJ and join BJ. Complete CBJI,* and draw JH and EF parallel to AB.

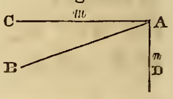
* Since JH=FE=AB, and HJI, JHI equal ABC, BAC ∴ BH passes through I.

Then AC : BC : : IJ $=$ BC : BI $=\frac{BC^2}{AC}$. But BI $=$ BG $+$ GH $+$ HI. Therefore $\frac{BC^2}{AC}=\frac{AB^2}{AC}+BF+AC$. Then $BC^2=AB^2+AC.BF+AC^2$, which gives the relation sought. This result includes the relation of the sides of a right angled triangle; for, if BAC be supposed a right angle, BF disappears, and we have $BC^2=AB^2+AC^2$. Or if, in the result we substitute the values supposed, in the mechanical problem just considered, we shall deduce $y=(1+2a\cos.A+a^2)^{\frac{1}{2}}$, as was proposed.—I now return to the last of the two methods mentioned, in the outset, for investigating the resultant of any two forces.

### *Method second.*

Let AB $=1$, (Fig. 4,) represent a force, in direction and intensity. Suppose the entire effect of the force, in the direction AC to be $m$. Its only residual effect, if but one, is at right angles to AB, and may be called $n$. Now the effect of $m$, in the direction AB is $m^2$, and that of $n$ in AB is $n^2$. Wherefore $m^2+n^2=1$, which determines the intensity of the resultant of two forces, $m$ and $n$, acting at right angles to each other.

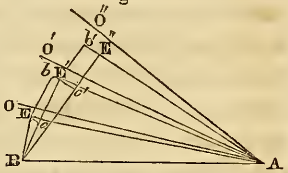
Fig. 4.




It remains to determine the direction of a resultant in relation to that of its resolved or component forces. For this purpose let ABE, ABE′, ABE″, &c. (Fig. 5,) be right angled triangles having a common hypothenuse AB; and let BAE be a unit angle, whereof BAE′, BAE″, &c. are the double, the triple, &c. Drop E*b* normal to A*b*, E′*b*′ to A*b*′, &c.; also E*c* normal to BE′, E′*c*′ to BE″, &c. As these lines are to be made the representatives of forces, let it be observed that they are so only in respect of *intensity*, and not of *direction*. Yet, when a *force* AE, E*b*, &c. is spoken of, the term includes not intensity alone, but that specific direction which the force, thus symbolized, shall have been previously defined to have.

This understood,—the pairs of lines AE, E*b*, AE′, E′B, AE″, E″B, &c. may, by what was before shown, represent the *intensity* of forces normal to each other, whose resultant is AB; and, if those forces would not have the *direction*, also, of the lines AE, EB, &c., let the direction in which the effect of AB shall be AE lie in the line AO. Then the residual effect will be EB, normal to AO. Make OAO′ equal to BAO; and, by what is already supposed, the effect of the *force* AE, in the direction AO′ will be A*b*, and its residual force will be *b*E normal to AO′. Then AB is the resultant of the three *forces* A*b*, *b*E, EB. But, since the force EB is normal to AO, its effect normal to AO′, by what is supposed, must be *c*B; also in the direction AO′, it must be E*c* or *b*E′. The first, combined with the force *b*E, constitutes the force E′B, normal to AO′, and the last, combined with the force A*b*, constitutes the force AE′; which therefore is the effect of AB in the direction AO′, and its residual effect normal to AO′, is E′B. In like manner may it be seen that, if O′AO″ be taken equal to BAO, the effect of AB in the direction AO″ is AE″, and its residual effect, normal to AO″, E″B; and, in general, that the effect of AB, at any multiple of BAO, would be represented, in intensity, by the cosine, to radius AB, of the same multiple of BAE, and, of course, its residual effect by the sine of the same. Conversely, also, it is evident, that if the effect of AB at any angle O″AB is represented by the cosine of another angle E″AB, then will the effect of AB, at any exact part, or measure of the first, be represented by the cosine of the same part of the second; and, of course, the same, *mutatis mutandis*, of the residual forces and sines.

Fig. 5.




To apply this to the point in hand,—let CAB (fig. 4) be supposed to vary from the corresponding angle of the diagonal of the parallelogram CAD, if completed; that is, from the angle which that diagonal would make with AC. Take $z$ any part or measure of the resultant angle, and $z'$ the same part of the corresponding diagonal angle. Take $nz$, $nz'$ multiples of these by an integral number. Then, by what has been proved, it appears that the effect of AB, at the angle $nz$ with its own direction, would be represented, in intensity, by the cosine of $nz'$. If, then, DAB and CAB are commensurable, the former may have $nz$ for its equal, and therefore $nz$, or DAB, must vary the same way, in respect to excess or defect, from the corresponding diagonal angle, as DAB from its corresponding diagonal angle; so that, in this case, the two together would constitute DAC less or greater than a right angle, which is impossible. But, if the two are not commensurable, there may be taken two multiples, $nz$ and $\overline{n+1}z$, between which DAB shall be intermediate. Therefore the effect of AB, at that angle, must be intermediate to its effects at $nz$ and $\overline{n+1}z$; so that the angle whose cosine represents the effect of AB, at DAB, must be intermediate to $nz'$ and $\overline{n+1}z'$; and, as $z$ and $z'$ may be taken to any required degree of minuteness, it is evident that, in every case, DAB must vary from its corresponding diagonal angle, in the way of excess or defect, as DAB varies from its corresponding diagonal angle, and therefore the two cannot constitute a right angle. But DAC is a right angle,—therefore AB cannot lie out of the direction of the diagonal of the parallelogram whose sides represent its component forces acting at right angles to each other. And if two forces are represented by two sides of a parallelogram which include any angle whatever, let the diagonal of the parallelogram which divides that angle be drawn, and let the effects of the two forces be taken, in that diagonal and normal to it, what we have already proved will show that the latter two are equal and opposite forces, and that the sum of the former is represented by the diagonal of the parallelogram,—which completes the point desired.

Respecting the two methods of proof that compose the body of this article I may be indulged in remarking, that I conceive them to be new, and to make the *rationale* of the problem of component and resultant forces easy of comprehension, to a perhaps unusual degree. They are dependent upon no ideas whose clear establishment in the mind, presupposes any considerable amount of mathematical study,—upon differentials and integrals, functions, infinitesimal considerations, or even trigonometrical formulas. But the conclusions are derived from the mechanical axioms by the aid, only, of the most elementary ideas of geometry or common algebra. Before closing I would drop the remark, that an inspection of fig. 5, in the last method of proof, coupled with the reasonings respecting its constituent lines, employed as symbols of force, may suggest a very simple and expeditious process for deriving the formulas for the cosines of multiple angles from the cosine of the unit angle.

Art. XV.—*Notice of an Ice Mountain in Wallingford, Rutland County, Vermont;* by S. Pearl Lathrop, M. D.

*Messrs. Silliman*—Having read, in a late number of your Journal, an interesting account of the "Ice Mountain" in Virginia, I have thought that an account of a similar mountain in Wallingford, Rutland County, Vt. would not be uninteresting to your readers.

The "Ice Bed," as it is usually called by the inhabitants of the town, is on the west side of the Green Mountains, about two miles west of Otter Creek, and half a mile south of the road leading from Wallingford to Mount Holly. The mountain at this place rises to the elevation of one thousand five hundred feet from its base, and about two thousand above the level of Otter Creek, presenting to the west an almost perpendicular mural front of light gray quartz rock, which may be seen at the distance of several miles, and called, from its color, "White Rock." From this high and hoary cliff have been precipitated to the foot of the mountain below, large masses of rock, varying in form and size, and weighing from a few to many hundred tons. An area from thirty to fifty acres has been covered by these masses, confusedly piled upon one another. In a deep and narrow ravine, opening to the southwest, and into which many of these rocks have been thrown, the ice is usually found. It is to this part, particularly, that the significant appellation of *Ice Bed* is given, as it is among the huge folds of this vast rocky drapery, that a large amount of ice *coolly* and calmly sleeps, during the hot months of summer, while its kindred element, in other places, melts with fervent heat. The ice is here formed every year, during the melting of the snow in the months of February, March and April, and disappears, in different seasons, from the last days of June to the first of September, varying in time according to the quality of the ice deposited and the heat of the spring and summer. From this *bed* large quantities of ice may be obtained, sufficient to supply the inhabitants of the adjacent towns. It is often visited for the purpose of getting ice, and by those who are invited thither by the refreshing atmosphere of the mountain, and the truly sublime picture the place affords. I know not the usual temperature of the atmosphere among the rocks, as indicated by the thermometer, but full well do I know that after being nearly melted by the burning rays of a summer's sun, and the exercise of ascending and descending the White Rocks, two thick coats were hardly sufficient to render me comfortable, as I sat upon a rock just above the spot where the ice is found, and received the cold air as it came up from the icy caverns beneath.

Various attempts have been made by ingenious philosophers to account for the formation and preservation of such a vast amount of ice, and in such a place. But no reasoning appears more satisfactory and conclusive than that offered in the account of the "Ice Mountain" in Virginia. That it is owing mainly to the fact, that rocks are poor conductors of caloric, must be evident to every one at all familiar with the well established laws of heat, and the many striking instances, which science has brought to light, of the non-conduction of heat by various substances.

The Ice Bed and the White Rocks are well worthy of being visited by the lovers of science, and those who are pleased with the grand and wonderful in the operations of nature. In a letter just received from Dr. Ives, who has long resided in Wallingford, and often visited the Ice Bed and White Rocks, he says:

"Standing in the ravine near the Ice Bed, those who have a taste for the sublime scenes of nature, cannot fail to be gratified in contemplating one of the most wild and awfully grand views that are to be found in the whole range of the Green Mountains. If surpassed by any scene in the Union, I have failed to notice it; and I have crossed this range at various points, and examined it with some attention, from the northern part of this State to its termination at West Rock, near New Haven, Conn. My eye has rested upon a large portion of the Alleghany and Cumberland mountains, and surveyed with thrilling interest the Highlands above New York, East and West Rock near New Haven, and the far-famed elevations of the Blue Ridge at Harper's Ferry, Virginia. But these justly celebrated scenes, though highly interesting, failed to impress me with that deep sense of the sublime, that I have never failed to experience while wandering among the vast moss-covered fragments of rock that are confusedly piled over the large space between the head of the glen and the foot of the riven cliffs."

At the bottom of the ravine described above, a small stream of water is formed, which varies but little during the year, and the temperature of which is very low.

Middlebury, Vt., Nov. 25, 1843.

Art. XVI.—*Views concerning Igneous Action, chiefly as deduced from the Phenomena presented by some of the Minerals and Rocks of the State of New York;* by Lewis C. Beck, M. D., Professor of Chemistry in Rutgers College, New Jersey.*

[Read before the Association of American Geologists and Naturalists, April, 1843.]

At the last meeting of the Association, I had the honor to submit some observations on the pseudomorphous minerals of New York, and in attempting to refer the changes there described to a general cause, I fixed upon igneous action as the one which was most consistent with all the phenomena.

The study of these and similar changes thus produced, and the examination of certain minerals which are confessedly of igneous origin, have led to some general views, which I now propose to lay before this meeting, with the facts from which they have been deduced.

Of the rocks usually termed *metamorphic*, or those which are supposed to have been changed by heat, there are numerous localities in the state of New York. Among these are white limestone, dolomite, gneiss, and perhaps mica slate. In regard to the white limestones, especially of St. Lawrence County, Dr. Emmons has so clearly established their igneous origin, that I shall offer nothing upon the general subject which he has elucidated. I must, however, advert to the appearances which both here and elsewhere some of the imbedded minerals exhibit.

At the noted locality in the town of Hammond, St. Lawrence County, the crystals of apatite, feldspar and pyroxene are often variously bent, and have their angles smooth and rounded as if by fusion, while crystals of zircon have been broken and their terminations moved from their original position. In the same county also, quartz crystals frequently occur with their terminations rounded even in a more striking manner than in the preceding minerals.

A similar appearance is presented by the crystals of scapolite, (Nuttallite,) which are found in great abundance in the white limestone, in the town of Diana, Lewis County. Among hundreds of specimens, there are very few which have their forms

* Communicated to this Journal by the author.

well defined. They usually have a *slaggy* aspect, their angles being obliterated, and their surfaces covered with a kind of glaze; while not unfrequently groups of crystals have coalesced into one mass or united together like the glass beads found among the ruins of the great fire in the city of New York, (1835.) These remarks will apply also to some of the other minerals associated with the scapolite, but the change is rarely so marked.

Facts similar to the above have been observed in Orange County, where the white limestone is frequently in beds in granite and gneiss. In the vicinity of Edenville the apatite found in this rock, often has the bent form and glazed appearance so characteristic of this mineral in St. Lawrence County; and at Amity the so called idocrase, has sometimes two or three perfect faces, while other parts of the crystal look as if they had been softened by heat, and in this softened state had accommodated themselves to the little cavities and fissures of the limestone.

It may here be remarked, that I have not hitherto observed any appearances like those above described in the dolomitic limestones of the southern part of New York. It is true the pseudomorphic forms of hornblende and pyroxene which I noticed in a former paper are very abundant; and these it will be observed, I have proposed to refer to an agency similar to that which seems to have produced the peculiarities exhibited in the minerals of the white limestones. It should be borne in mind, however, that for some reason or other, there is a greater poverty of minerals in the dolomites than in the latter rocks. In the former, the different varieties of hornblende and pyroxene are almost the only species, if we except those found in a few metallic veins, some scales of mica, and thin layers of jasper or hornstone. On the other hand, the white limestones abound in spinelle, chondrodite, crystallized mica, feldspar, tourmaline, apatite, scapolite, sphene, graphite, hornblende, pyroxene, and several others which it is not necessary to enumerate.

I proceed now to notice some peculiarities of the minerals found in gneiss and mica slate. The occurrence of crystallized garnets in these rocks has been adverted to by Mr. J. Phillips, as an evidence that the whole mass has been subjected to a pervading high temperature. "The occurrence of garnets," he adds, "in mica schist and gneiss is entirely unconnected with any local effect of heat, derived from particular masses of granite, greenstone, &c.; nor can their occurrence be often accounted for by any supposition of their having formed part of more ancient rocks, which by disintegration yielded them to the watery currents concerned in accumulating the primary strata; for they are in general, *perfectly crystallized* among fragmentary scales of mica, and worn and broken feldspar and quartz, or granular aggregates of those substances, scarcely differing in arrangement or aspect of the parts from particular sandstones and coarse argillaceous slates."*

In the gneiss of New York and Westchester counties, which often abuts the dolomitic beds, garnets frequently occur, but they are seldom perfectly crystallized, being more or less rounded, either by attrition or fusion. This is strikingly exhibited in the vicinity of Yonkers, in Westchester, where these rounded garnets are very abundant in the gneiss, and are from one fourth to three fourths of an inch in diameter. Here too, large masses of garnet have been found; in one instance nearly a foot in diameter, and firmly attached to the rock on all sides. In the more crystalline parts of this formation, as at West Farms and New Rochelle, the garnets, much less abundant, however, do not exhibit this peculiarity in so decided a manner, but they are seldom well crystallized.

In the vein of coarse granite in the town of Greenfield, Saratoga County, celebrated for the occurrence of chrysoberyl and other minerals, the garnets have a trapezoidal form, but perfect crystals are almost unknown. And the same remark will apply to the small pink garnets found in the gneiss of the Noses, in Montgomery County. Indeed, although I have seen a great number of specimens from all the preceding localities, I do not recollect ever to have met with a perfect crystal.

Garnet, in almost every variety of color, is abundant at several localities in Essex County; as Rogers' Rock, Lewis and Willsborough. But crystalline forms are exceedingly rare, and are found only in the rifts and fissures of the rock.

I think myself warranted in the assertion, that throughout the state of New York, when garnets occur in gneiss or in granitic veins, they are imperfectly crystallized; and in many, if not most cases, they present the appearance of having undergone some change through the influence of heat or otherwise, subsequently to their original crystallization.

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* Treatise on Geology, II, 103.

On the contrary, when found in the mica slate this mineral almost invariably exhibits a perfect form and a fine finish. Such are the crystals from Dover, Dutchess County, and I might add those in the mica slate in Monroe, (Conn.) Delaware County, (Penn.) &c.

From the facts which have now been presented, the conclusion seems to me almost irresistible, that whatever may have been the agency by which these minerals were originally segregated, the rocks in which they are found were subsequently subjected to a high temperature ;—sufficiently high at least, to soften many of the minerals imbedded in them. Thus we can account for the bent and rounded crystals of feldspar, apatite, quartz, scapolite, &c., so abundant in many parts of the state, and for the similar appearances presented by the garnet in gneiss. The mica slate having been farther removed from the supposed source of heat, has its imbedded crystals more perfectly developed.

In many of these cases, the crystals were undoubtedly formed at first in obedience to the laws of crystallization. But we have no reason to believe that these laws were exerted so as to give rise to those irregularities of surface and structure, those contortions and fractures and glazings which they now exhibit. On the contrary, these appearances are entirely similar to those which we know to be produced, by subjecting perfect crystals enclosed in a sufficient quantity of sand or rock, to a high degree of heat.

It has been thought by some geologists to be a necessary condition, that during the time these changes were effected the limestone must have been covered with water to have prevented the rock from undergoing calcination. It is well known, however, that even in an ordinary kiln, it requires a very high heat to calcine small masses of limestone, and unless some moisture is present, and layers of combustible matter interposed between those of the limestone, the evolution of carbonic acid is exceedingly sluggish.

The pillars of the old Exchange in the city of New York, constructed of white dolomitic marble, suffered little alteration by the intense heat of the great fire of 1835, which raged for twenty-four hours, and destroyed more than six hundred houses. They were somewhat disintegrated on the outside, and perhaps throughout became a little more granular, but there was no appreciable loss of carbonic acid. It seems to me, therefore, not unreasonable to suppose, that a large bed of limestone may have been subjected to a degree of heat sufficient to soften or fuse sundry imbedded minerals, without causing any marked alteration in the chemical composition of the rock. Nor is it difficult to understand how those rocks in the immediate vicinity of the source of heat, or of the heating mass, should exhibit appearances quite different from those more remote. Thus we may account for the fusion of certain minerals in the white limestone and the gneiss, while in those found in the mica slate there is no apparent change. Thus also, there is an explanation of the fact that one part of a limestone bed may be dolomitized, while another remains in its supposed original condition.

In proceeding to the consideration of other evidences of igneous action, I may observe that there is one circumstance applicable to all the minerals found in the primary masses, with the exception of serpentine, too striking not to deserve particular attention. I refer to the absence of water, at least in any thing like atomic proportions, as one of their constituents. When it is recollected that this substance is a common ingredient of those minerals which are found in fissures of trap and greenstone, and in the lavas which have been ejected from volcanoes, we may perhaps infer with safety, that water was not evolved from the central nucleus during the earlier geological eras.

I have said that serpentine is an exception to the statement just made, in regard to the absence of water in the minerals of the primary masses. Now serpentine, which is oftentimes very abundant in white limestone, and exists even in extensive beds, constantly contains from ten to twenty per cent. of water.

Several foreign localities are described which exhibit the change of trap into serpentine, and others in which dykes and masses of serpentine occur under circumstances similar to those of trap rock. Facts of a similar kind, are observed in the state of New York. Thus on Staten Island, serpentine forms the main ridge of hills, and extends nearly eight miles in a direction N. 20° E. and S. 20° W. It assumes a variety of aspects, and contains hydrate and carbonate of magnesia, asbestus, &c. The prolongation of the line of direction strikes the serpentine hills of Hoboken, which are similarly characterized, and hand specimens of which can scarcely be distinguished from those obtained on Staten Island. On the west of this range is the trap rock, which is exposed for two or three hundred yards near Port Richmond, and which again appears at Bergen, New Jersey, and onward forms the Palisadoes of the Hudson. The connexion between this range and the serpentine is too obvious to need farther notice.

Serpentine has been found on the island of New York, but not in large masses. On the peninsula east of New Rochelle in Westchester County, it is abundant, and has the appearance of a distinct dyke. Its structure is somewhat columnar, and it is every where traversed by seams of softer magnesian minerals, asbestus, &c. On the west, it is said to be bounded by hornblende rocks, while on the east is a limestone more or less mixed with serpentine.

Similar in their characters, are several deposits of serpentine in the counties of Dutchess and Putnam. At Brown's quarry in the latter county, this columnar or basaltic appearance is well exhibited. The serpentine is here very dark colored, and varies in its structure from compact to coarse crystalline, like some hornblendic rocks; to which, indeed, in hand specimens, it not unfrequently bears a close resemblance. The fissures contain crystals of hornblende, plates of Schiller spar, and dark colored tremolite.

There is a fine illustration of the intimate connexion between trap and serpentine, although upon a small scale, on Stony Point in the county of Rockland. Trap dykes pass up the northwestern face of this hill, which are well marked in consequence of the decomposition of the hornblende rock. Now these dykes are every where traversed by a soft greenish substance belonging to the serpentine family. They contain also asbestus in very delicate silky fibres.

In Lewis County, near Natural Bridge, where trap dykes and trappean aggregates are not unfrequent, there are mural precipices made up chiefly of the substance called Rensselaerite by Dr. Emmons, but which I suppose to be a mixture of steatite or serpentine with pyroxene. The same mineral occurs in unbroken ledges in the vicinity of Ox Bow, Jefferson County, a region in which well characterized trap dykes are common.

So also in St. Lawrence and Essex counties, whenever serpentine is found in any abundance, dykes of trappean rocks are to be seen in the immediate vicinity.

We have strong grounds, therefore, for adopting the theory of the igneous origin of serpentine, were we furnished only with the proofs which are here exhibited. But if this is the correct view, how happens it that while all the minerals of the granite, gneiss and limestone, are destitute of water, the serpentines are almost always loaded with that substance? Is it because the strata were covered with water during the period of the extrusion of serpentine, a condition which did not exist when the other minerals were first crystallized, or when they received the broken, bent, rounded and slaggy forms and appearances which they every where present? Or is it because in later geological periods, water was a more constant accompaniment of the erupted matter? These are questions upon which, perhaps some light may be shed by a reference to the composition of the minerals found in certain trappean rocks, as compared with those which are known to be the products of true volcanoes.

In the 17th volume of the London, Edinburgh and Dublin Philosophical Magazine, Dr. Thomas Thomson has given a detailed account of the minerals occurring in the Kilpatrick hills, which bound the valley of the Clyde from the Stokey Muir to Dumbarton. These hills are composed of various trap rocks, among which amygdaloid is pretty common. The cavities of this variety are usually filled up by crystallized minerals, many of which, though not the whole, belong to the zeolite family. Dr. Thomson divides the minerals found in these hills into two sets. 1st. The *zeolites*, so called, because they froth before the blowpipe, and they owe this frothing property to the great quantity of water which they contain, and which is easily driven off by heat. 2d. Minerals nearly destitute of water, which in general, although not in all cases, exist in greater quantities than the zeolites, and may be often considered as constituting an integrant portion of the substance of the mountain in which they occur.

Thirteen of these zeolites are enumerated, viz. stellite, Thomsonite, natrolite, scolezite, glottalite, laumonite, chabazite, analcime, Cluthalite, stilbite, Heulandite, harmatome and Phillipsite. These are chiefly silicates of alumine and lime, and they contain from two to six atoms of water. To these may be added, prehnite, datholite, apophyllite and Morvenite, which also contain water as one of their constituents.

We have only to examine a list of the minerals found at Bergen Hill, Paterson, and Bound Brook in New Jersey, at Piermont in New York, and in the trap rocks of Massachusetts and Connecticut, to satisfy ourselves that these hydrous forms are by no means confined to one region or district, but seem at least in general to characterize the less ancient exhibitions of igneous action.

If the question be now asked, whether the occurrence of these minerals, from which the water can be expelled by moderate degrees of heat, is not inconsistent with the idea that the whole rocks were ejected in a molten state, I refer the inquirer to the products of volcanoes. Nearly one hundred species of minerals are enumerated as occurring among the lavas of Vesuvius, and a considerable number of these are characterized by their containing water as one of their atomic constituents. I may here refer to Gehlenite, Davyne, mesotype, Comptonite, sulphate of ammonia, potash and soda—alum, &c. Nor need we be long in doubt as to the source of this water, when we see steam frequently ejected from volcanoes, and various compounds of hydrogen among their products.

I have thus noticed the difference in the effects of heat as exhibited in the minerals found in the older rocks and in those of more modern eras, and have offered some suggestions in regard to the cause of this difference, drawn chiefly from the total absence of water in the one class, and its frequent presence in the other. Let us now see what use can be made of the facts here brought forward, in determining the nature of those rocks which are commonly supposed to be the "floor" upon which the strata are deposited.

All geologists agree that the unstratified rocks "are generally of the nature of granite, that is to say, largely crystallized aggregates of feldspar, with variable admixtures of mica and quartz,—or more rarely quartz and hornblende,—or quartz and hypersthene." Granite is now considered, in whatever variety it may present itself, "as an older rock than any of the strata which rest upon it." It is not, however, as was formerly supposed when granite was thought to be of aqueous origin, necessarily the product of an anterior epoch. There seems now to be no doubt, "that in very many cases the granite has been in a state of fusion since the deposition of several of the older formations, so that it has actually been injected into the fissures and cracks of these strata, or been raised up in a fluid mass among them." In the language of Mr. Phillips, whom I have already quoted—"We may, therefore, consistently admit granite as well as other igneous rocks, to be of any, that is, of all ages; some of that which is visible in the crust of the globe may have been solidified from fusion before the production of any of the strata; other granite has been melted or remelted at various later periods; granite may yet be forming in the deeper parts of the earth, round the centres of volcanic fires; but in general we must look on this rock as characteristic of particular circumstances accompanying igneous action, not as belonging to particular periods of geological history."*

Granite of the ordinary kind is composed of quartz, feldspar and mica, and it is somewhat remarkable, that although there may be considerable variations in the proportions of these substances, they would give rise to only slight differences in chemical composition. These constituents, according to De la Beche and Phillips, are

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| Silica, . . . . | from | 73·00 | to | 75·00 |
| Alumina, . . . . | " | 10·90 | " | 13·83 |
| Potash, . . . . | " | 7·48 | " | 9·80 |

together with small proportions of other bodies, as magnesia, lime, oxide of iron, oxide of manganese, and fluoric acid.

Moreover, there does not appear to be a very remarkable difference in chemical composition between common granite and those rocks which are confessedly of igneous origin, except perhaps that arising from the fact that in the latter, the mica is generally less abundant, and the quantity of hornblende is greatly increased.

If now it should be asked, whether these igneous products owe their origin to the fusion of ordinary granite, were we to attend exclusively to the composition of the rocks, the answer would probably be an affirmative one. Such indeed seems to be that implied in the statements of De la Beche, Phillips, and other geologists.† But if we look to the imbedded minerals, it will be found extremely difficult to reconcile their chemical composition and mode of formation with this view. Although it may be freely admitted that the different varieties of granite, when subjected to intense heat, *might* produce rocks not unlike those

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* Treatise on Geology, I, 108—111.

† It is qualified, however, by the admitted difference between the granitic and trappean rocks, the former being more prevalent at the earliest periods,—a difference which is ascribed to a "modification in the condition of things."

which now constitute the traps and the various kinds of lava, it is difficult to understand, upon this hypothesis, why the fissures and cavities of the latter, should contain minerals differing entirely in crystalline forms, and in many instances yielding substances not known to exist in the rock from which they are said to be derived.* Even granting that the constituents of these minerals actually exist in the granite, the chemical mineralogist will be slow to believe that, at such distant localities and in such widely separated epochs, the very same, as it were, *accidental segregation* of certain substances should take place. He would be more likely to infer that these minerals had previously existed, at least in their anhydrous state,—that they had been liquefied by heat, and that in their subsequent crystallization they were merely obeying the laws of molecular attraction which regulate this process.

It may be here observed, that the reference of these igneous products to ordinary granite is based upon the assumption, that this latter rock not only constitutes the floor of all the strata which have been observed, but that it forms the nucleus of the globe. But after all, do not the trappean rocks and minerals show a difference in composition, as well as in the arrangement of their constituents? Are not these, as well as our modern lavas, the representatives of series of rocks or of materials, whether solid or liquid, differing considerably from granite? If they are so, then with the knowledge which we possess in regard to the deep seated source of volcanic action, we may conclude that the lavas ejected by volcanoes, and the trappean rocks which resemble them, although found in the cracks and fissures of the most recent strata, in fact belong to a series lower than any which we see upon the surface of the earth. And perhaps by a close examination of the chemical theory of volcanic eruptions, we shall be enabled to comprehend the differences to which we have referred, especially if we are willing to admit that the conditions of these modern eruptions were different from those which characterized the older ones.

* "Admitting this prevalence of granitic compounds at the earliest periods, their production at more recent epochs shows that the conditions necessary for their formation continued up to such epochs, though they may have been infinitely more rare, having in a great measure given place to those under which the more common trappean rocks were produced."—*De la Beche*, 475, *Am. ed.*

In reviewing the facts set forth in this paper, we arrive at the following conclusions, viz.

1st. That if it is admitted that the original protrusion of granite was due to igneous action, and if to this is to be ascribed the crystallization of the minerals found in the primary beds and strata, these must in many cases have been a second time subjected to a high temperature,—high enough at least to cause the partial fusion of these minerals.

2d. That at later geological periods the presence of water became another, and perhaps new condition, of the great igneous agency, and that hence serpentine with its large proportion of water was one of the results.

3d. That the presence of water, known to be an almost invariable condition of modern volcanic action, is proved to have been no less so during the periods when the eruptions of the trappean rocks took place.

Finally, I have endeavored to show that as we proceed to the interior of the earth there are arrangements of mineral forms quite different from those which characterize the lowest of the primary rocks as they appear on the surface. Now I think it conceivable that the character of the igneous eruptions may have been connected with circumstances attending the different depths to which the refrigeration, and consequently the solidification of the crust may have extended. When the granitic deposits had been but partially solidified, fissures and cracks in the crust would be followed by injections of the same mineral ingredients, in some instances perhaps sparingly mixed with those below. Hence the formation of true granitic veins with their accompanying minerals, during such a state of things, might be easily accounted for. But as the solidification extended towards the interior, the erupted matter would exhibit a different aspect, owing perhaps in part to the new agencies which were brought into action, but chiefly to a real difference in the mineral matter or composition, which we have reason to believe exists in different parts of the central nucleus, or at different distances from the surface.

ART. XVII.—*On the possible Variation in the Length of the Day, or of the Times of Rotation of the Earth upon its Axis;* by W. W. MATHER, Professor of Natural History in Ohio University.

*Messrs. Editors*—Will you permit me through your columns, to correct an error and oversight in that volume of the Natural History of New York, that treats of the geology of the first district of New York.* It is too late to correct the errors in the work itself, as it is published. A hasty preparation of the article while the printers were waiting for copy caused one of the errors, which any mathematical reader would detect at a glance.

On the 638th page, a formula is given to show approximatively the change in the length of the day, or of the period of a revolution of the earth on its axis, upon the hypothesis of a variable diameter of the globe at different periods of time.

The proportion there stated, from which the formula is deduced, is erroneous in two particulars, and the calculation based upon it is necessarily wrong. The proportion alluded to is as follows: "$\frac{1}{r^4} : \frac{1}{r'^4} :: v : v' :: t : t'$." *The two last terms of this proportion should have been* $t' : t$, whence $t' = \frac{tr'^4}{r^4} = 24^h \frac{(3955)^4}{(3956)^4}$ (miles) $=$ $23^h\ 58'\ 32''\ 29'''$.

The time of a rotation of the earth on its axis, when considered as a sphere, with a radius one mile less than the present mean radius, would be $23^h\ 58'\ 32''\ 29'''$ or $1'\ 27''\ 31'''$ less than our day, on the assumption that the times of rotation are proportional to the fourth power of the radii. It is believed that the

* The arrangement of the work on the Natural History of New York, published under the authority and at the expense of the state, as the final report on the "Geological Survey," is as follows, viz.—

Part I. Zoology of the State, by J. E. Dekay, 6 vols. 4to. Part II. Botany of the State, by J. Torrey, 2 vols. 4to. Part III. Mineralogy of the State, by L. C. Beck, 1 vol. 4to. Part IV. Geology—Part 1st, Geology of 1st District, by Wm. W. Mather, 1 vol. 4to; Part 2d, Geology of 2d District, by E. Emmons, 1 vol. 4to; Part 3d, Geology of 3d District, by L. Vanuxem, 1 vol. 4to; Part 4th, Geology of 4th District, by J. Hall, 1 vol. 4to. Part V. Palæontology of the State, by J. Hall, 1 vol. 4to. Part VI. Agriculture of the State, by E. Emmons, 1 vol. 4to.

fourth power of the radius in the above formula, does not express the true relation.

The angular velocity of a revolving body is represented by the well known formula $\omega = \frac{MRv}{\Sigma(mr^2)} = \frac{MRv}{m'k^2}$ =in the sphere $\frac{MRv}{m'\frac{2}{5}r^2}$; hence, since M and $m'$ in the same mass are identical, and since R and $v$ and $\frac{2}{5}$ are constants, $\omega \propto \frac{1}{r^2}$ and $\omega : \omega' :: \frac{1}{r^2} : \frac{1}{r'^2}$. Therefore, the angular velocities of a sphere of the same constant mass, but variable in volume, impelled by the same force, are inversely proportional to the *squares* of the radii, instead of the fourth powers, as given in the formula.

Since the angular velocities are also inversely proportional to the times of rotation, the squares of the radii are proportional to the times of rotation, or $r^2 : r'^2 :: t : t'$ and $t' = \frac{tr'^2}{r^2}$. This is the formula that *should* have been used in the calculation on the 638th page of the Geology of the 1st District of New York, as affording an approximation to the time of a revolution of the earth on its axis under the assumed condition of varying in diameter.

If we apply this formula, supposing the radius of the earth to be one mile less than its present mean radius, the time of a revolution on its axis would be $23^h\ 59'\ 16''$, or the day would be shortened about 44 seconds.*

A diminution in the length of the day of one second would correspond to a diminished radius of about 40 yards.† M. La Place has shown that the sidereal day, or true time of rotation of the earth, has not varied $\frac{1}{300}$ part of a centesimal second during 2000 years. To find what diminution of the mean radius corresponds to this minute fraction of time, we have from the above formula $r'^2 = \frac{r^2 t'}{t} = \frac{(3956)^2\text{ miles} \times (24^h - \frac{1}{300}'')}{24^h}$. Whence $r - r'$ is equal

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* $t' = \frac{tr'^2}{r^2} = \frac{24^h(3955)^2\text{ miles}}{(3956)^2} = 23^h\ 59'\ 16''$.

† Prof. A. Ryors of the Ohio University, made this calculation about a year ago from the same formula here used, but deduced in a different way. Vide his lecture on Gravitation before the Chillicothe Lyceum.—Since this article was in type I have learned that the same formula is given in Poisson's Mechanics, 2d edition, Tome II, p. 460.

to the diminution $=1\frac{6}{10}$ inches; or for the sexagesimal second, $=0.000077$ mile $=4\frac{87}{100}$ inches.

These minute quantities are insufficient to account for the geological evidences of the diminished diameter of the globe, inferred from facts stated in the work alluded to, unless the period of time be regarded as almost infinite, but it is believed that a clue is perceived, by which compensating forces would maintain the time of rotation nearly uniform, and the day of nearly an invariable length, even if the earth be either gradually or paroxysmally undergoing a slight change in its dimensions.

Ohio University, Athens, Dec. 9th, 1843.

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Art. XVIII.—*An Account of some new Instruments and Processes for the Analysis of the Carbonates;* by Profs. William B. Rogers and Robert E. Rogers, of the Univ. of Virginia.

The importance of some ready means of determining the composition of the calcareous and other carbonates, so extensively used in agriculture and the chemical arts, and the frequent necessity of such analyses in the course of chemical research, have suggested various forms of apparatus and modes of proceeding adapted to this purpose. Of these the most generally used are—*first*, that of Rose, as described in his Chemlcal Analysis, in which the quantity of carbonate present is determined from the weight of the carbonic acid expelled; *secondly*, that of mingling the carbonate and hydrochloric acid in a graduated tube over mercury, and estimating the amount of the pure carbonate from the volume of carbonic acid which collects in the tube; and *thirdly*, that of adding to the carbonate an acid of *known strength*, until neutralization is effected, and computing the amount of carbonate from the quantity of acid used. To these may be added, the modifications of Rose's apparatus employed by Fritche, and by Erdman and Marchand; the very neat process of Dr. J. L. Smith, described in this Journal, Vol. xlv, p. 262, which is an application of the last of the three methods above mentioned; and the ingenious but cumbrous, and we think inexact, instrument recently proposed by Drs. Will and Fresenius.*

* We may also add the method recently proposed by M. Schaffgoetsch, (Poggendorff, Ann. der Phys. und Chem. 1842,) which is as follows. In a platina crucible holding about 18 grammes of water, are placed from 2 to 7 grammes of glass of

The instruments and processes which we are about to describe, are the suggestions of a long course of experience in the laboratory—have been submitted to numerous and varied trials, and have been carefully compared with the modes in general use; so that we feel some confidence in offering them, through the pages of this Journal, to the criticism of practical chemists.

I. Apparatus and process for the approximate analysis of the carbonates.

The apparatus first to be noticed is a modification of that described by one of us (W. B. R.) in the Journal many years ago.* Even in its early and ruder form, this instrument was found to furnish useful approximate results, with so much more ease and expedition than the methods commonly employed, that of Rose included, as to prove of great value in the numerous economical analyses of calcareous marls and other materials in which we were then engaging. In its improved shape, combining greatly superior accuracy with increased facility of manipulation, we have used it very satisfactorily for the last eight years, in many hundred of the *ordinary analyses* connected with the geological surveys of Virginia, Pennsylvania and New Jersey.

The instrument, as thus modified, is represented in fig. 1. It consists of a light flask or bottle, measuring about two cubic inches, a globular pipette drawn out to a very slender tapering tube below, a gum-elastic bag secured air-tight to the top of the pipette, and a drying tube, filled for the middle two thirds of its length with chloride of calcium, and near the ends with loosely packed cotton. The pipette and drying tube are passed through a smoothly drilled cork, so as to fit air-tight, the former projecting three fourths of an inch into the flask. The cork is so adjusted as to be withdrawn along with the pipette, and the pipette is charged without separating it from the cork. This gives room for the introduction of the carbonate into the flask, and obviates the danger, after the pipette has been charged with acid, of touching its moistened beak to the cork. Lastly, the surfaces of the

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borax, which is fused by a double current spirit lamp. When cold—it should be cooled under a desiccator, over sulphuric acid—it is weighed, and a weighed quantity of the carbonate placed in it; the whole is now again submitted to fusion. When again cooled as before, the loss of weight is carbonic acid. If the substance contains water, it is driven off at the same time with the carbonic acid, and of course its quantity must be estimated in the usual way.—B. S. Jr.

* Vide Am. Jour. Vol. xxvii, p. 299.

cork, flask, pipette and drying tube are coated with a varnish of shell-lac, to protect the cork from infiltration, and to diminish the hygrometric action of the surface generally.

In using the instrument, a weighed quantity, say 40 grains, of the carbonate is placed in the flask, and if it be in powder, enough water is added to moisten it throughout. The pipette is then charged with hydrochloric or sulphuric acid, by placing its open end in a capsule containing this liquid, compressing the gum-elastic bag, and then allowing its elastic expansion to pump the acid into the bulb. Sometimes the pipette thus charged, when held upright, permits the liquid slowly to accumulate in a drop, at its beak, thus endangering a premature descent of the acid upon the carbonate, which would vitiate the experiment. This is effectually prevented by lightly pressing the bag and allowing it to recoil so as to draw a short column of air into the tube, near the end. The cork bearing the pipette and drying tube, being then secured in the flask, the acid will remain supported without any tendency to ooze out, and the instrument is in a condition to be placed in the balance to be counterpoised. This done it must be removed and placed upon a clean dry surface, near the balance, where, gently pressing the bag, the acid is to be projected in a fine stream on the carbonate, the action being regulated so as to maintain a steady but not too violent effervescence. When all the carbonate has been decomposed, which in the case of a marl or limestone occupies but a few minutes, the acid still in the bulb must be expelled into the flask.

To remove the carbonic acid remaining in the instrument after the completion of the reaction, a large drying tube must be annexed to the end of that belonging to the apparatus, and the gum-elastic bag must then be made to operate as *a pump*, by alternate compression and dilation. Continuing this action for some time, the gas is in great part if not wholly expelled, while the air entering from without at each alternation of the movement, deposits its moisture in the *large drying tube*, instead of adding it to the weight of the apparatus, as it would were this appendage omitted.* The second weighing is now performed, and the loss of

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* The error here adverted to, must also arise in the use of Rose's apparatus, whenever, as Parnell directs, heat is applied to expel the carbonic acid remaining at the close of the action. For the air entering as the flask grows cool, must increase the normal weight by the amount of moisture it contains.

weight gives, by the usual procedure, the amount of the carbonate in the known quantity of material used.

Long experience with this instrument, especially as applied to the alkaline and earthy carbonates, solid and in solution, has satisfied us, that with the precautions above described, it yields more uniform results than either of the methods commonly employed, while it possesses the important advantage of facility and promptness in the manipulation. By comparing it with more perfect arrangements, hereafter to be described, we have found that with proper care, it enables us to ascertain the amount of carbonate present, *to within one tenth of a per cent.*, a degree of accuracy, which, without the utmost precaution, is we believe, rarely attained with Rose's apparatus, and which greatly exceeds that of the operation with the graduated tube over mercury.

The errors to which it is exposed, arise from two causes; *first*, the difficulty of removing the last traces of carbonic acid from the air of the flask and pipette, by the pumping operation above described, and *secondly*, the union of a portion of the carbonic acid with the liquid in the flask. To these may perhaps be added a slight endosmose through the gum-elastic bag, though of this we have no certain evidence. Without therefore claiming for it all the accuracy required in an instrument for refined research, we offer it to the attention of practical chemists as a valuable help in the important class of chemical enquiries relating to the composition of marls, calcareous soils and certain manufactured products, where despatch is of more importance than the highest degree of precision in the result.

Of the sources of error above mentioned, that of the *retention of part of the carbonic acid by the liquid* in the flask, is by far the most important, and as will be shown hereafter, in the case of Rose's process and its modifications by Fritche, and by Erdman and Marchand, is of such magnitude, even when sulphuric acid is employed, as greatly to impair the value of the results for the purposes of nice investigation.

Besides this source of inaccuracy, common to Rose's and our own process, we have detected another peculiar to the former, and which operates whenever hydrochloric acid is employed in his apparatus. This is *the evolution of carbonic acid from the surface of the carbonate*, caused by the action of the acid vapor, during the time of the first weighing, and which occasions, as we have repeatedly witnessed, a sensible diminution of the weight of the apparatus while resting on the balance. So considerable is the amount of this action with some substances, where as in cases of nice research, much time is occupied in the counterpoising, that we believe the results thus obtained can not fail of being seriously erroneous.

II. Apparatus and processes for the more exact analysis of the carbonates.

Incited by the recent researches and impressive suggestions of Dumas, in relation to the equivalents of oxygen, carbon and calcium, we several months ago entered upon a series of investigations, to test for ourselves the accuracy of the received atomic weights of lime, magnesia, baryta, strontia, soda and potassa, proposing as the simplest means of effecting this object, to determine the amount of carbonic acid, evolved from the pure carbonates, by some process similar in principle to that above described. Repeated trials, however, convinced us that the imperfections already mentioned as incident to Rose's process and our own, though of but little moment in ordinary analysis, unfitted them for the higher description of research, on which we were desirous of entering. A more critical examination of the sources of irregularity and error, in these and the other methods of analysis, at length led us to the forms of apparatus, and modes of procedure, which we have since employed with very satisfactory results.

These instruments and manipulations, we will now proceed to sketch, accompanying the description, with a reference to some of the experiments used as tests of the accuracy of our process, or as proofs of the errors not hitherto adverted to in the methods commonly in use. Of the results of our enquiries thus far, as regards chemical equivalents, some notice will be given under a distinct head in a future number of this Journal.

The main apparatus, that in which the decomposition is effected, and which is weighed at the beginning and close of the process, is of two distinct forms, adapted to the different characters of the carbonates under examination. Of these, one is seen forming the middle portion of fig. 2, the other is delineated in fig. 3.

The body of the instrument in both cases, consists of a light, wide-mouthed bottle, having a capacity of about three cubic inches, closed by a cork three fourths of an inch in thickness. In *the first form*, the cork receives the tapering ends of two drying tubes, the one horizontal, the other vertical, both projecting a short distance into the bottle. It is also penetrated centrally by a stout platinum wire about four inches long, hooked at the lower and bent twice at the upper end. A thin glass bucket for containing the solid carbonate, is represented in the figure as hanging within the bottle. This is perforated at bottom, and furnished with a handle of platinum wire, to allow of its suspension from the upper and from the lower hook, in the successive stages of manipulation. Such is the arrangement we employ in experiments with carbonates of lime, baryta and soda, and the other carbonates which admit of accurate weighing while exposed.

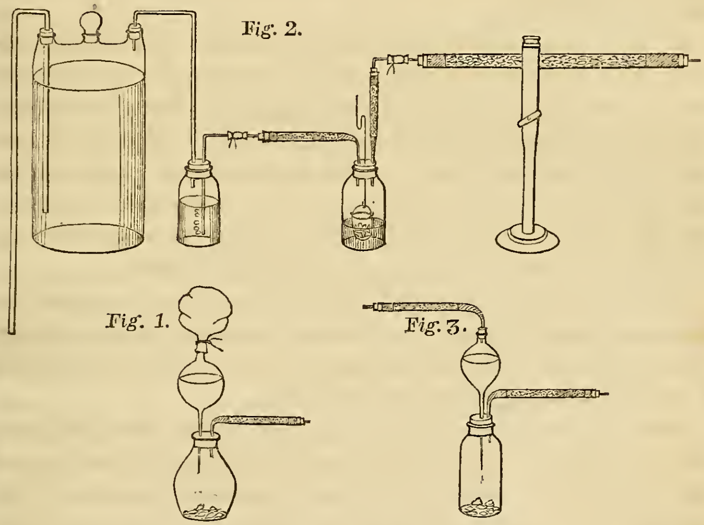

*Fig. 2.* *Fig. 1.* *Fig. 3.*

*In the second form*, the platinum wire and glass bucket are omitted; the carbonate enclosed in a thin, sealed tube, is placed at the bottom of the bottle, and the hydrochloric acid retained until needed in the globular pipette above. The latter appendage, drawn out to a delicate and even tube below, is inserted through the centre of the cork, and projects into the bottle about three fourths of an inch. As in this arrangement, which is free from the errors incident to the use of the gum-elastic bag, the column of acid is exposed to an undiminished atmospheric pressure at top, some care is necessary in forming the tapering stem of the pipette, otherwise the liquid will escape in drops during the first weighing. This is obviated by a very *gentle* convergence of the tube, and by drawing in a column of air, so as to fill the lower half, or two thirds of its length. With these precautions, we have found the acid to be retained in the bulb, without the slightest tendency to drop. The drying tubes belonging to this form, are both bent horizontally, and inserted, the one through the cork of the bottle, the other through that of the pipette. This form of the instrument we use for such carbonates as are very hygrometric, and could not therefore be weighed in the bucket, and also for such as are very bulky, as those of mangnesia and zinc. We have moreover found it more convenient than the other, where the compound formed by the reaction is insoluble, and forms a pasty mass, as when sulphuric acid is employed to decompose carbonate of lime.

In both forms of the apparatus, the outside of the bottle, pipette and drying tubes, should be well coated with a smooth varnish of shell-lac, and the corks, and especially that of the bottle, should be repeatedly coated and dried, so as to be well imbued with the varnish for some depth. This is so important a precaution, that unless the large cork happen to be uncommonly close in texture, the permeation through it, in experiments of long continuance, is capable of producing very serious errors.

To the parts here described, which in both forms compose the apparatus proper, certain appendages are added in the course of the experiment. These, as shown in fig. 2, to the left and right of the decomposing bottle, are as follows.

First.—*A large drying tube* ten inches long, occupied for an inch at each end with dry cotton, and throughout the intervening eight inches, with chloride of calcium properly desiccated. This, supported in a horizontal position, is connected by a gum-elastic tube with the little supplemental bent portion of the upright drying tube. It is made thus long to ensure the absence of moisture in the air drawn into the apparatus, in the process of aspiration.

Second.—*An arrangement for aspiration*, consisting of a three necked Wolfe's bottle, holding about fifty cubic inches, to which are adapted a long glass syphon on the one side, a bent connecting tube on the other, and a ground stopper in the middle aperture. The bottle being filled with water, the syphon is made to operate by applying the lips below, and a stream of dry air is drawn into and through the apparatus, as long as the water continues to flow. A short tube drawn to a small orifice and made to fit over the end of the syphon, or what is better a small stop-cock, may be used to regulate the stream.

Third.—*A test bottle,* containing a solution of nitrate of silver, placed between the decomposing vessel and the instrument for aspiration. This appendage is introduced in the figure and referred to here, not because we deem it essential, when the operation is conducted with even common care, but as necessary to complete the picture of the apparatus of research, as used by us in our experiments. It will be shown hereafter, contrary to the intimation of Erdmañ and Marchand, that hydrochloric acid *does not* pass through the drying tubes, either in company with the stream of evolved carbonic acid, or during the aspiration with the air. As however an extreme violence in the effervescence, accidentally occasioned, *might* cause some of it to escape, a fact not yet witnessed in any of our experiments, we continue to use this appendage as a sentinel to give us notice of the error.

In adjusting the apparatus for use, great care should be taken to make all the connections, from the remote end of the large drying tube, to the short tube of the test bottle inclusive, perfectly *air tight.* To be sure of this, after putting the parts together, the end of the drying tube should be closed by a little fragment of soft cement, then setting the syphon in operation, if the junctions referred to are perfectly close, the stream of bubbles rising through the solution of nitrate, will soon entirely cease. The importance of this air-tight connection, will at once appear from considering that during the aspiration, the smallest opening in the corks or gum-elastic tubes of the decomposing bottle and its drying tubes, by giving admission to air from without, must increase the weight of the instrument, by the amount of moisture it brings with it, an increase which even in a seemingly tight condition of the apparatus, when the above precaution was not used, has in some of our experiments amounted to two one-hundreths of a grain.

To facilitate the removal of the apparatus, proper for its connection, previous to the second weighing, the binding string should be fastened by loop knots with long ends. This caution, however insignificant it may appear, is necessary to prevent the *handling* of the instrument, and to avoid any loosening of the corks. It may also be added, that in moving the instrument to or from the scale, it should be held by the horizontal tube, between the folds of a piece of clean buckskin. For accurate research, the experiments should be made in a dry atmosphere, of very uniform temperature, so as to dispense with any rubbing of the apparatus before weighing, a proceeding which though commonly practiced, frequently leads, according to our observations, to much uncertainty in the subsequent counterpoising. This result is in part due to the deposition of moisture on the apparatus, in the act of weighing, which even in a uniform condition of the air as to humidity, must be unequal in the first and last weighings, unless the temperature of the vessel, and the time consumed in the process, be the same in both cases. But a still larger share of the effect is chargeable, according to our experiments, to the electrical excitement produced in the glass by the friction, which, communicated to the scale pan, affects the apparent weight.

We will now briefly sketch our mode of using the apparatus in exact research, and describe a further process, which we have found necessary for expelling the carbonic acid from the liquid.

When the bucket is used, a small bit of tissue paper is pressed down upon its bottom, so as completely to close the hole, and then the weighed carbonate, usually one hundred grains, carefully transferred into it. Having charged the bottle with moderately dilute hydrochloric or sulphuric acid, in quantity a good deal more than is required to neutralize the carbonate, and having properly adjusted the cork, we hang the bucket with its contents upon the upper hook of the platinum wire, and lifting the apparatus into the scale by the buckskin holder, we counterpoise it with great care. Then withdrawing it from the scale, we lift off the bucket, remove the cork, attach the bucket to the *lower hook*, previously drawn up so as nearly to touch the lower side of the cork, and again secure the cork in its place. As it now hangs the bucket is from one half to three fourths of an inch above the level of the liquid. Depressing the wire, we plunge the bucket into the fluid, which enters by the aperture below, and varying the depth of immersion from time to time, we regulate the effervescence, so as to be uniformly brisk, but without great violence.

The effervescence having ended, as shown by the absence of any crepitation when the ear is held close to the flask, the liquid is briskly agitated to favor the escape of adhering bubbles, and the instrument is now connected with the appendages above described, in the manner indicated in fig. 2. The syphon being set in action, and the closeness of the connection ascertained, as before directed, the aspiration is commenced. During this process, which occupies from fifteen to twenty minutes, drawing through the apparatus fifty cubic inches of dry air, the bottle is several times gently shaken from side to side, to promote the escape of the combined carbonic acid from the liquid. The instrument is now withdrawn from the appendages, and again placed on the scale to be weighed. In this second weighing, it will sometimes happen, that the apparatus loses while on the scale, a small amount of weight, rarely however exceeding a few thousandths of a grain, arising as we have clearly proved, from the gradual escape of more of the combined carbonic acid from the liquid. In such cases we repeat the process of aspiration, after which the weight remains without sensible diminution during the weighing.

In using the pipette form of apparatus, for the deliquescent carbonates, the substance to be examined is placed in a thin glass tube, previously weighed. The tube is then drawn out nearly to a point by the use of a weighed fragment of a glass rod over an alcohol lamp. Sufficient heat being applied thoroughly to dry the carbonate, the fine end of the tube is closed, and the whole suffered to cool down to the surrounding temperature. The point of the tube is then removed with a sharp file, to allow air to enter, after which it is closed by the application of a small stopper of wax cement of known weight. In this condition the tube, together with the little piece removed from its point, and the fragment of rod, are placed in the scale and counterpoised. The entire weight, thus obtained, diminished by the sum of the weights of the tube, rod and stopper, gives the weight of the dry carbonate in the tube.

The pipette being charged with acid and adjusted so as not to produce drops, the tube is allowed to fall into the bottle with such force as to be broken, and the cork is instantly secured in its place. To inject the acid into the bottle, we attach the *large drying tube* to the upper drying tube of the instrument, and then operate either by suction with the mouth applied to a little mouthpiece at the other end of the apparatus, or by connecting it with the appendage for aspiration. In all the other steps the process is the same as where the bucket is employed.

The weight of the carbonic acid employed, being then accurately determined, the process has reached the stage at which it has heretofore been regarded as terminated, but numerous observations have proved to us that, even after two protracted aspirations, the amount of carbonic acid retained by the liquid, is far too considerable to be overlooked, and that to effect its complete separation, it is necessary to boil the liquid.

To separate and measure this portion of the carbonic acid, we employ a tube of thin glass, about twenty four inches long and one fourth of an inch in calibre, closed at one end, and graduated at this extremity to fiftieths of a cubic inch. Pouring mercury into this, until the vacant space above is not much more than sufficient to contain all the liquid in the bottle, we pour the liquid upon the mercury, holding the tube in an inclined position, so as to produce as little agitation as possible, and then add mercury until the tube is completely filled. Inverting the instrument in a bowl of mercury and supporting it in an inclined position, we apply the flame of a spirit lamp to the part containing the acid solution. But little carbonic acid is evolved, until near the boiling point. The bubbles then rapidly ascend and the gas continues to be disengaged even after the commencement of ebullition, so that to ensure its entire separation, this temperature should be maintained for two or three minutes. The tube, placed in an erect position, may now be brought to the temperature of the apartment by a moist cloth.

*A saturated solution of common salt* being poured upon the mercury in the bowl, the tube is to be raised a little, so as to permit this liquid to ascend and take the place of the mercury in the tube, after which the instrument is transferred to a deep, narrow jar, filled also with the saturated solution, and is depressed to the proper level for measuring the volume of the included gas. As this volume always includes a minute quantity of common air, disengaged from the liquid by boiling, the tube must now be transferred to a large cistern of water, when by continued agitation for a minute or two, all the carbonic acid will be absorbed, and thus its volume made known by subtraction. These processes being conducted at or near the temperature of the room, or the volume being corrected for expansion, should the temperature be much higher, the height of the residuary carbonic acid is given with sufficient accuracy, by estimating each tenth of a cubic inch as equivalent to 0·047 grain.

This supplemental process, though seemingly tedious and troublesome, is readily completed in from fifteen to twenty minutes, and *ought never to be omitted*, when great accuracy is in view. As proving its importance, we may state that in the great number of experiments, which we have made within the last few months, by the method above described, we have found the amount of absorbed carbonic acid, to be rarely less than one twentieth, and sometimes as much as one fifteenth of a cubic inch; *varying thus from one twentieth of a per cent. to one fifth of a per cent. of the whole weight of that substance contained in the carbonate employed.*

That the carbonic acid thus united with the liquid, cannot be expelled by Rose's method, is apparent from the fact that its removal can only be effected by an actual boiling of the liquid, and this if attempted in the flask, would lead to far more serious errors, than that proposed to be corrected. In proof of the latter statement, we would refer to the following experiments.

1st. Having prepared a solution with carbonate of lime, and the usual charge of dilute hydrochloric acid, and boiled it to expel the dissolved carbonic acid, we introduced it into a small bottle furnished with an ample drying tube, the junctions being all secured air tight. After careful counterpoising at 64°, we heated it gradually over a small lamp, until it began briskly to boil. On withdrawing it from the lamp, the chloride of calcium was found to have been moistened by the condensed steam, for about half the length of the tube. The original temperature restored, the instrument was placed in the scale. It had lost five tenths of a grain.

2d. Supposing that this loss might be due to the escape of hydrochloric acid, we made a similar trial with sulphuric acid, and found the reduction of weight to be about six tenths of a grain.

3d. Still further to assure ourselves that the hydrochloric acid had not escaped in the former experiment, we renewed the charge, and while heating the liquid, passed the vapor and air, as they escaped from the drying tube, through a solution of nitrate of silver in a test glass. No impression was made upon the test solution, up to the period at which the former experiment was discontinued. But as soon as the whole length of the drying tube was moistened by condensed vapor, the escape of hydrochloric acid was indicated by dense curds of the precipitated chloride. A like trial with the sulphuric solution gave, even *earlier*, the same result, the sulphuric acid carried over with the steam, decomposing the chloride of calcium and liberating hydrochloric acid.

*It is evident therefore that the application to Rose's apparatus of a heat sufficient to expel the carbonic acid from the solution, is entirely inadmissible, whichever solvent we employ.* It is scarcely necessary to add that this remark is also applicable to the apparatus of Fritche, that of Will and Fresenius, and that of Erdman and Marchand.

As in a recent memoir of the two chemists last named, they express a preference for *sulphuric acid* in experiments of this kind, it becomes important to our enquiries to ascertain whether the sulphuric solution produced in such case, would retain enough carbonic acid to make the boiling process necessary. We therefore introduced into the bottle one hundred grains of carbonate of lime, and poured upon it a sufficient amount of sulphuric acid, diluted with an equal bulk of water, to prevent the formation of a thick magma. Notwithstanding the large excess of acid, and frequent agitations of the liquid, the action towards its close was extremely slow, so that at the end of four hours, a slight crepitation could be heard on stirring the mixture. When this had entirely ceased, the liquid was heated in the graduated tube as above described. As the temperature approached boiling, carbonic acid was evolved, and at the close of the process, the volume of this gas collected was upwards of four tenths of a cubic inch. A similar result was obtained with several other carbonates and sulphuric acid.

We are therefore justified in affirming, that the solution or mixture formed in this process, whether sulphuric or hydrochloric acid be used, always contains an amount of carbonic acid too great to be overlooked in accurate research; that this carbonic acid cannot be expelled by a heat below boiling, and that such a temperature cannot be applied to the liquid *while in the apparatus*, without entirely vitiating the result. We therefore attach much importance, in cases of nice research, to the separate heating of the liquid, and we believe that with proper care the process for that purpose above described, will give the amount of residuary carbonic acid with all needful exactness.

The critical nature of the researches in which we proposed to employ the above mentioned instruments and processes, made it necessary, before entering on the main objects of investigation, to submit every step of the operation to the severest scrutiny. Most of the results of this test examination have already been stated, and we will merely add that the important fact of the non-escape of any of the hydrochloric acid, either during the effervescence, or in the process of aspiration, of which we early satisfied ourselves by direct experiments, has been still more conclusively proved by the constant use of the test bottle in the numerous analyses we have since performed. As an index of how entirely the acid is retained within the instrument proper, we would call attention to the fact that a solution of nitrate of silver, which has been used by us in the test bottle during the last ten or more operations, and through which more than eight hundred cubic inches of air, after passing over the acid liquid, has been slowly transmitted, is as unclouded now as when first placed in the vessel. The chief agency in thus arresting the hydrochloric acid, is due to the moisture deposited by the carbonic acid, during the effervescence, in the cotton packing, at the inner ends of the drying tubes, and we have found that when the cotton is quite dry and the aspiration is made from a bottle containing only hydrochloric acid, traces of this soon show themselves in the test tube. Cotton fibre even when dry is capable, according to our experiments, of absorbing twice its weight of the acid vapor, but when moistened, even no more than by exposure to the damp breath, its absorbent power is very greatly increased. It appears therefore, that no fears need be entertained of the escape of hydrochloric acid vapor, where the test tubes are charged as above described; and we are therefore at liberty to use this acid in the numerous instances where its employment would in all other respects be preferred.

In conclusion we would beg to say, that we have been led to enter thus minutely into many of the details of the processes here described, because we believe that by them we shall be enabled to investigate with unlooked for accuracy, the equivalents of a large number of substances, and because we desire that all the particulars of the methods we adopt, should be submitted to the criticism of experienced chemists.

## Art. XIX.—*Description and Analysis of Pickeringite, a native Magnesian Alum;* by Augustus A. Hayes.

This mineral occurs in masses, which are composed of long parallel fibres, easily divisible, and generally affords rhombic prismatic forms. There are numerous cross-fissures, and the fracture at these is even. Transparent to translucent, having the satin-like lustre of the finest specimens of satin spar, which it much resembles. Color white, but when viewed in the direction of the fibres, pale rose red, or a delicate green. Taste, like that of alum. Sp. gr. 1·78 to 1·80. In dry air it effloresces, in moist air it attracts water, and the fibres become flexible. It is soluble in cold water, without residue, and the solution has an acid action.

By chemical analysis, it affords

| | |
|---|---|
| Water of crystallization, | 45·450 |
| Sulphuric acid, | 36·322 |
| Alumina, | 12·130 |
| Magnesia, | 4·682 |
| Protoxides of manganese and iron, | 0·430 |
| Lime, | 0·126 |
| Hydrochloric acid, | 0·604 |
| Loss, | 0·256 |
| | 100·000 |

Neglecting the substances, evidently existing in the state of mixture with the double salt of alumina, its chemical formula is

$$\dot{Mg}\,\dddot{S}+\dddot{\bar{Al}}\,\dddot{S}^3+22\dot{\bar{H}}.*$$

In the analysis, bicarbonate of ammonia was used for precipitating the alumina and retaining the larger part of the magnesia, in solution with the sulphuric and hydrochloric acids. The precipitate was ignited, so long as it lost weight; it was then redissolved in strong nitric acid, and its solution was decomposed by a large excess of potash solution. The hydrates, insoluble in a

* The water in the above analysis approaches so near 24 atoms, that this is probably the amount contained, in which respect it will then conform to the general formula for the alums, $\dot{R}\dddot{S}+\dddot{\bar{Al}}\dddot{S}^3+24\dot{\bar{H}}$. The exact formula would be $(\dot{Mg},\dot{Mn},\dot{Fe})\dddot{S}+\dddot{\bar{Al}}\dddot{S}^3+24\dot{\bar{H}}$, which, excepting the iron, is identical with that of an African alum analyzed by Stromeyer. (See Rammelsberg's Handwörterbuch, &c. Vol. I, p. 10; also Dana's Mineralogy, 2d edition, 1844, p. 554.)—Eds.

boiling solution of caustic potash, were redissolved in hydrochloric acid; the lime was combined with oxalic acid and separated. A solution of chlorine in carbonate of soda removed manganese and alumina, leaving only magnesia in solution. The small quantity of magnesia was estimated as an ammonia phosphate.

The solution containing an excess of bicarbonate of ammonia was boiled, and thus rendered slightly acid. Nitrate of silver removed the chlòrine of the hydrochloric acid, as chloride of silver; neither iodine or bromine could be detected. On rendering the fluid acid, by hydrochloric acid, the silver was separated, and hydrochlorate of baryta separated the sulphuric acid, as a pure sulphate of baryta. By an excess of sulphuric acid and evaporation, the baryta was precipitated, and the clear solution of saline matter was slowly reduced to a dry mass. By heating with the usual precautions, a light gray anhydrous sulphate of magnesia was obtained, from the weight of which, the weight of the magnesia was calculated and added to that precipitated with the alumina. By warm water, some flocks of ferruginous oxide of manganese had been separated from the dry saline matter; these were added to those from the alumina, and all converted by heat into the red oxide, from which the weights of protoxides were calculated. For determining the quantity of water contained in the mineral, a part of the fragments used in the above analysis, and weighed from the same state of dryness in air at 84° F., was chosen. Fifty parts contained in a tube retort, connected with a vessel of ammoniacal solution, were heated slowly and uniformly. The porous mass lost 22·625 parts, and the ammonia had received 0·268 of hydrochloric acid. On heating the mass till vapors of sulphuric acid were disengaged, the loss was 23·310. The sulphuric acid weighed, in the state of sulphate of baryta, 0·287 parts, which, with 0·268 of hydrochloric acid, give ·585 of acids, which were deducted from the total loss of weight due to heating. This mineral generally contains phosphoric acid, which in part replaces the sulphuric acid. It precipitates in union with the alumina, and appears to be an accidental impregnation. I found the most ready mode of detecting its presence in the alumina, to be that of forming ammonia alum, by adding a great excess of muriate of ammonia to a sulphuric solution while warm. On cooling, not only alum, but crystals of muriate of ammonia should form. By washing these crystals in a solution of muriate of ammonia, all the phosphoric acid which was combined with the alumina remains in the fluid.

This mineral occurs in large quantity, in South Peru, near the port of Iquique. It invests the well known flesh-colored trachyte, and is mixed with masses of sulphates of ammonia, soda and magnesia, and salts of iron. The careful examinations of these saline deposits of Peru, by Mr. John H. Blake, led to the discovery of this mineral, and I have named it in compliment to John Pickering, Esq., the learned and distinguished President of the American Academy of Sciences.

Roxbury Laboratory, March 8, 1844.

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Art. XX.—*System of Mineralogy, including the most Recent Discoveries, Foreign and American;* 640 pp. large 8vo, with 320 Wood Cuts, and four Copper Plates, containing 150 additional Figures. By James D. Dana, A. M. London and New York: Wiley & Putnam. 1844.

It is seven years since we had the pleasure of announcing the first edition of this valuable work. (Vol. xxxii, p. 387.) The sale of a large edition of a book so purely scientific in this space of time gives good evidence alike of the growing interest in the subject in America, and of the high place which Mr. Dana's system holds in the estimation of mineralogists. During the period which has passed since the appearance of the first edition, the science of mineralogy has made rapid advances both in Europe and in this country. Abroad, many eminent chemists have been working up the obscure parts of the subject, and throwing new light on those better known. "The progress in analysis is especially apparent in the growing interest excited for the natural method of classification, and the opening prospect that, before long, the chemical and natural systems will be identical. There formerly seemed to be no bond of union between the species, hornblende, augite, tabular spar, acmite, and manganese spar, and in chemical methods we have found one with the ores of manganese, another with those of iron, another with salts of lime, and so on; but even Chemistry now suggests the natural system of arrangement, and demands their union in a single family, as given in some of the latest chemical treatises. Numerous other instances, given in our remarks on Classification, illustrate the fact that the natural system is founded actually on chemical principles."—*Preface.* On this side the water, the numerous geological and mineralogical surveys which have been commenced or brought to a close, have done much to diffuse a taste for such studies among the mass of the people, and to awaken a spirit of inquiry, which, under the direction of the eminent gentlemen charged with the several parts of the work, has developed to a good degree our mineralogical resources. "Sources of information have thus been laid open for making a thorough American work on Mineralogy; and it has been the endeavor of the author to avail himself fully of these various aids, to render, if possible, the present treatise deserving of this title." Many new species have been added to our former lists, and doubtless many proposed which are not new. Many old ones have been made to coalesce with others previously established,* while old names that had been discarded are again brought into use.†

The following catalogue contains the more interesting of the new foreign species added to this edition of Mr. Dana's treatise.

| | | |
|---|---|---|
| Apatelite. | Beaumontite, (crenate of copper.) | Greenovite. |
| Potash copperas. | Bromic silver. | Perowskite. |
| Soda copperas. | Iodic mercury. | Œrstedite. |
| Oxalate of lime. | Rosite. | Mosandrite. |
| Pissophane. | Hydrargillite. | Wöhlerite. |
| Leucophane. | Gigantolite. | Euxenite. |
| Magnesian pharmacolite. | Villarsite. | Uranotantalite. |
| Bromlite. | Lepidomelane. | Heteroclin. |
| Romeine. | Hydrous mica. | Anthosiderite. |
| Antimonophyllite. | Ryacolite. | Wehrlite. |
| Nussierite. | Andesine. | Irite. |
| Selenate of lead. | Oligoclase. | Placodine. |
| Volborthite. | Periclase. | Xanthokon. |
| Delevauxene. | Rhodizite. | Zinkenite. |
| | | Geocronite. |

* "Among the species that have disappeared, the following are the most important: Comptonite, united with Thomsonite; Biotine, with Anorthite; Elæolite, Davyne, Cancrinite, and Gieseckite, with Nepheline; Mellilite, with Humboldtilite; Junkerite, with common Spathic Iron; Levyne, Gmelinite, and Phacolite, with Chabazite; and Gismondine, including Aricite and Zeagonite, with Phillipsite."—*Preface.*

† The celebrated works of Von Kobell and Rammelsberg, and the new edition of Mohs's System, have also been published since 1837.

| | | |
|---|---|---|
| Plagionite. | Pyrosclerite. | Fichtelite. |
| Voltzite. | Thrombolite. | Könlite. |
| Greenockite. | Variscite. | Hartite. |
| Faujasite. | Krisuvigite. | Ixolyte. |
| Malthacite. | Kammererite. | Guyaquillite. |
| Ottrelite. | Fossil copal. | Berengelite. |
| Pelokonite. | Middletonite. | Pigotite. |
| Praseolite. | | |

It is surprising, considering the correctness of this treatise on its first appearance, to find how numerous and important are the changes which have been made in the present edition.

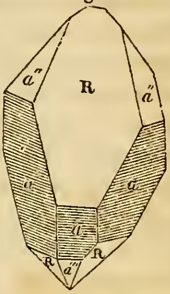
In the volume already quoted, we have given a full outline of the plan and general arrangement of Mr. Dana's work, which it is the less necessary to repeat at present, since the first edition is in the hands of so many of our readers. The mathematical appendix of the first edition is omitted in most of the present one; only a few are bound up with it for the satisfaction of those who wish to pursue that portion of the subject. Notwithstanding this omission, the present edition is considerably larger than the former—the whole amount of new matter being little short of one hundred and fifty pages. It is in fact to all intents and purposes a new book, modelled on the general plan of the former, but altered in many important points to suit it to the present advanced state of the science. Without farther preface, therefore, we proceed to give in as condensed a form as possible some of the novel features of greatest interest which strike our eye in the work, following the order of the contents.

*Irregularities of Crystals.*—Under this head, (which constitutes the 3d chapter,) we have an important addition, and an able exposition of a subject which is the cause of much perplexity to the student, and, when rightly understood, unfolds many difficulties and apparent anomalies, both in the form and composition of minerals. The irregularities of crystals are treated of under four heads. 1. Imperfections of surface; 2. Variations of form and dimensions; 3. Internal imperfections and impurities; 4. Pseudomorphous crystallizations. Under the first head we have—

1. *Striated Surfaces.*—" These are produced by minute planes covering the surfaces striated, and usually inclosed parallel to the seconda-

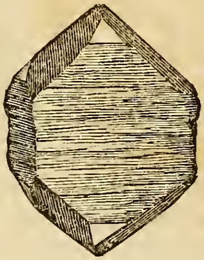
ry or primary planes of the crystals, and we may suppose these ridges to have been formed by a continued oscillation in the operation of the causes that give rise, when acting uninterruptedly, to enlarged planes. By this means the surfaces of a crystal are marked in parallel lines meeting at an angle, and constituting the ridges referred to. This combination of different planes in the formation of a surface has been termed the *oscillatory combination.* The horizontal striæ on prismatic crystals of quartz, (Fig. 1,) are examples of this combination, in which the oscillation has taken place between the prismatic and pyramidal planes. As the crystals lengthened, there was apparently a continual effort to assume the terminal pyramidal planes, which effort was interruptedly overcome by a strong tendency to an increase in the length of the prism. In this manner, crystals of quartz are often tapered to a point, without the usual pyramidal terminations."

Fig. 1.




" Diagonal striæ sometimes occur on the faces of a cube showing an oscillatory combination between the cube and octahedron. The rhombic dodecahedron is often striated parallel either with the *longer* or the *shorter* diagonal of its faces; the *former* resulting from an oscillatory combination of the dodecahedron with the regular octahedron, and the *latter*, with the cube or planes bevelling the edges of the cube, as in *Aplome.* The accompanying figure represents a distorted crystal of magnetic iron from Haddam, Ct., illustrating the oscillation between the octahedron and dodecahedron. The faces of trapezohedral garnets are often striated parallel with the symmetrical diagonal, showing an oscillation with the dodecahedron."

Fig. 2.



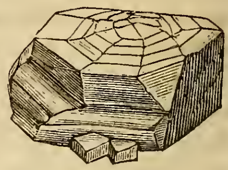
2. *Variations in the forms and dimensions of Crystals.*—" The simplest modification of form in crystals, consists in a simple variation in length or breadth, without a disparity in similar secondary planes. The distortion, however, extends very generally to the secondary planes, especially when the elongation of a crystal takes place in the direction of a diagonal, instead of the crystallographic axes. In many instances, one or more secondary planes are *obliterated* by the enlargement of others, proving a source of much perplexity to the young student. The interfacial angles remain constant, unaffected by any of these variations in form.

" As most of the difficulties in the study of crystals arise from these distortions, this subject is one of great importance to the student."

Following the order of his crystallographic system, Mr. Dana unfolds this intricate subject by a beautiful series of figures, of which we can notice only the following:—

"Figure 3 represents a crystal of Galena from Rossie. It is a shortened cube; the lateral faces are very irregularly curved, and consist of the primary faces of the cube and the planes truncating the lateral edges. Some of the terminal edges are also truncated. The crystal is surrounded by a low pyramid, consisting of four planes on each of the angles and edges, which, owing to the distortion, do not occur elsewhere on the crystal. The cleavages of the crystal easily explain the relations of the several planes to the primary."

Fig. 3.



"Figure 5 of apatite is the same form that is represented in figure 4, but greatly distorted. The planes e′, e, e″, between P and the right M,

Fig. 4.

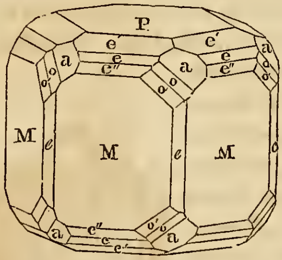
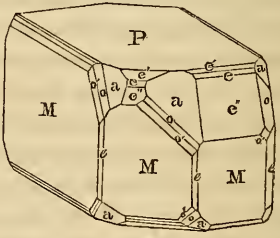



Fig. 5.




are enlarged, while the corresponding planes below are in part obliterated. By observing that similar planes are lettered alike, the two figures may be compared throughout."

Fig. 6.

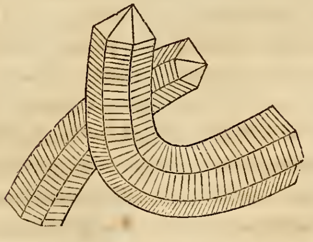
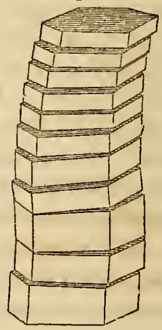


Fig. 7.



"*Curved Crystals.*—Curves in imbedded crystals are of frequent occurrence; and in implanted crystals they are not very uncommon. The annexed figure of quartz, (fig. 6,) illustrates this kind of distortion; the same is described by Beck as occurring in the apatite of St. Lawrence Co., N. Y. Six-sided prisms of calc spar are occasionally curved in the same manner.

"In many species the crystals appear as if they had been broken transversely into many pieces, a slight displacement of which has given a curved form to the prism. This is common in tourmaline and beryl. The beryl from Monroe, Ct., often presents these interrupted curvatures as represented in figure 7."

In Vol. XLII, p. 206, of this Journal, Dr. John Locke described some very curious instances of curved crystallizations of gypsum, from Mammoth Cave, in Kentucky. Mr. Dana has given two excellent figures of this species of distortion, drawn from specimens in the collections of the National Institute at Washington. Sir John Herschel has also described similar forms in ice on the stalks of plants, (Phil. Mag. 1833, II, 110,) and we had the pleasure of observing the same phenomenon recently on the stalks of the Helianthemum corymbosum and H. Canadense.

"*Variations in the Angles of Crystals.*—Variations in the angles arising from curvatures and imperfections of surface have been alluded to. Other variations are owing to impurities in the crystal. Calcareous spar is one of the most noted instances of this variation; it varies from 105° to 105° 17′. Pure crystals have the constant angle 105° 5′. These variations are in general so small as seldom to cause any difficulty in practice. Secondary planes, lustre, cleavage, and other peculiarities, will always distinguish a cube from a square prism, although the angles differ but 1″ from one another.

"From the investigations of Mitscherlich it is ascertained that the angles of crystals vary with the temperature. In passing from 32° to 212° F., the angle of calc spar was diminished $8\frac{1}{2}'$, thus approaching the form of a cube as the temperature increased. Dolomite, in the same range of temperature, diminished 4′ 6″. The angle of the prism of arragonite was increased 2′ 46″ while passing from 63° to 212° F."

3. *Internal imperfections and impurities.*—This is a head capable of much expansion. The controlling influence exerted by the menstruum or medium, while minerals are taking on their forms, particularly as regards the chemical constitution of species, has not hitherto received sufficient attention. We have no doubt that when this subject has been thoroughly investigated, much of the present complexity of the formulas given for many species will vanish, and the small per cent. of many matters discovered by chemical analysis and not essential to

the existence of the mineral as a normal chemical salt, will prove to be only mechanical mixture. Indeed, already we discover with pleasure a disposition in foreign chemists of eminence, to simplify as far as possible their formulas. Mr. Dana has in his preface the following judicious remarks on this subject.

"Notwithstanding the well-known principle that crystallizing substances may include, mechanically, the impurities present in a solution, a fact often discoverable with the naked eye, chemists very generally include in the formula every ingredient obtained by analysis, however small the proportion. In some species, as quartz, lime, heavy spar, celestine, macles of andalusite, auriferous pyrites, and a few others, mechanical mixtures are allowed; but in most cases, especially if the mineral be a complex one, mechanical impurity seems hardly to be thought of as a possibility: while, in truth, the detection of an ingredient, in small quantity, in an opaque crystallized mineral, is neither proof of its mechanical, nor of its chemical combination; and some farther evidence should be required before coming to any conclusion on this point. Had the possibility of mechanical mixtures been more considered, and a doubt indulged when chemistry seemed to clash with crystallography, the science would have been encumbered with fewer synonyms. As an example:—the Peristerite of a British chemist would have been left in undisturbed union with feldspar: it requires but a common magnifier to detect the impurities (minute spangles, apparently of mica) in the red stripes of this red-and-white iridescent feldspar from Upper Canada; and it is very probable that quartz may be segregated, on known principles, in the white stripes, like the mica in the red. These facts explain the peculiar composition of this mineral, the analysis of which Rammelsberg quotes with expressions of distrust; and if their bearing on the composition of other minerals were admitted, we should find the chemist less hasty in urging forward new species on chemical grounds alone."

The impurities often take a symmetrical arrangement, generally collecting most abundantly about the centre and along the diagonal, and also in planes between the centre and edges of the crystal. In chiastolite the foreign matter is arranged about the central axis, and in planes running from this axis to the edges, and also about the lateral edges and exterior surfaces of the crystal. The accompanying figure, illustrating these principles, represents a macle of Staurotide, discovered by Dr. C. T. Jackson, resembling those of

Fig. 7.

Andalusite. The mica from Jones' Creek, near Baltimore, contains opaque lines or bands in concentric hexagonal figures which arise from the same cause. p. 54.

Section 11. *Crystallogeny.*—This section is divided into two parts.

1. The *theoretical* part, containing the various theories which have been adduced to account for the structure of crystals, and a particular illustration of that which appears to be most consistent with facts.

2. The *practical* part, including the different processes of crystallization and the attendant circumstances.

The original and profound views of the author on the following questions—" What are the laws by which molecules are superimposed on molecules in perfect order, and these tiny yet wonderful specimens of architecture constructed? What is this crystallogenic attraction? What the nature of the ultimate particles of matter?"—are unfolded in the early part of this section. He gives in the first place, a succinct account of the history of the subject, which is one that has exercised the ingenuity of the most profound philosophers. It has been before said in this Journal, (Vol. xxxii, p. 388,) that "after much examination of this matter, we do not hesitate to declare our opinion, that this mysterious problem, which since the days of Epicurus has been so often unsuccessfully attacked, is at length here solved."* It is a satisfactory circumstance that this somewhat bold conclusion has been borne out by the evidence of so great an authority as M. Necker, who has fully recognized the correctness of Mr. Dana's views. (Bibliothèque Universelle.)

Under the heads of *isomorphism* and *dimorphism*, the recent views of Dr. H. Kopp are introduced, (p. 88,) as well as those of Mitscherlich and Rose.

" *Isomorphism.*—The isomorphism of certain substances must be attributed to some similarity in the nature of the molecules, in consequence of which they produce, in their combinations, compound molecules of similar ellipsoidal form and similar axes. Lime and protoxyd of iron are thus allied, and the qualities of their molecules are so alike, that, on uniting with the same substance in like proportions, the compound molecule has nearly or quite the same form, and similarly ar-

* Mr. Dana's article on the formation of crystals, may be found at length in this Journal, Vol. xxx, p. 275.

ranged axes. Dr. H. Kopp has lately shown that isomorphic bodies have equal atomic volumes, and draws the conclusion that isomorphism is owing to an equality in the volume of the atoms, or plesiomorphism to an approach to equality. Those bodies that replace one another without changing the crystalline form, have atoms of equal volumes, and their isomorphous compounds are also equal in atomic volume. He obtains the atomic volume by dividing the atomic weight by the specific gravity, and thus shows for a great number of the acknowledged isomorphous or rather plesiomorphous minerals, a close approach to one another, in the volumes of their atoms. For example, for the carbonates of zinc and magnesia, mesitine, carbonates of iron and manganese, dolomite, and calc spar, he found the atomic volume as given in the following table:

| | Atomic volume. | Axis *a*. | Angle. |
|---|---|---|---|
| Carbonate of Zinc, | 175·33 | 0·807 | 107° 40′ |
| Carbonate of Magnesia, | 181·25 | 0·812 | 107 25 |
| Mesitine, | 186·26 | 0·815 | 107 14 |
| Carbonate of Iron, | 188·50 | 0·819 | 107 0 |
| Carbonate of Manganese, | 202·29 | 0·822 | 106 51 |
| Dolomite, | 202·36 | 0·833 | 106 15 |
| Calc Spar, | 231·20 | 0·854 | 105 15 |

"The above table, which contains also the axis *a*, and the angle of the rhombohedron, of each of these minerals, illustrates the interesting fact, which he next deduces, that the axis increases, or the angle diminishes, as the atomic volume increases. He also derives a formula for calculating the volume from the length of the axis, and finds it to give results coinciding very nearly with the above. These principles are illustrated by numerous examples, for which reference may be had to Brewster's Philosophical Magazine for April, 1841, p. 255.

"Since an increase of atomic volume is connected in the above minerals with an increase of the axis *a*, and heat, by diminishing the density, necessarily increases the volume of the atom, therefore the axis *a* must be lengthened by heat, as is actually the case. Mitscherlich found the specific gravity of calc spar diminished by a heat of 180° F. in the proportion 1 : $\frac{1}{1\cdot001961}$, and Dr. Kopp, by calculation determines that for 180° F. the angle of the crystal should be changed 7′ 37″, which is but 57″ less than Mitscherlich's observations—a near coincidence, when we consider the difficulties which necessarily accompany the direct measurement of the dilatation and change of angles.

"These principles proceed on the hypothesis of simple *spherical* or *spheroidal atoms* for compound bodies, and the theory of atoms proposed by the author receives from them strong confirmation.

"*Dimorphism.*—Dimorphism has been shown by Mitscherlich, Rose and others, to result in many instances from the different temperatures attending crystallization. When a *right rhombic* prism of sulphate of zinc is heated to 126° F., certain points in its surface become opaque, and from these points bunches of crystals shoot forth, in the interior of the specimen; and in a short time, the whole is converted into an aggregate of these crystals diverging from several centres on the surface of the original crystal. These small crystals thus formed at 126° F., are *oblique* rhombic prisms; and the same form may be obtained by evaporating a solution, at this temperature, or above it. Sulphur crystallizes from fusion in oblique rhombic prisms, while the common form obtained by evaporation is a rhombic octahedron. Rose has obtained crystals of arragonite by evaporating a solution of carbonate of lime to dryness by means of a water bath, and crystals of calc spar by permitting the solution to evaporate in an open vessel at the ordinary temperature. The crystals of arragonite were minute six-sided prisms and double six-sided pyramids. They change to rhombohedrons of calc spar if left moist; but if washed and dried at once, they remain permanent. By exposing arragonite to a low temperature, the crystal falls to pieces, in consequence of the change to calc spar which takes place; or if the prisms hold together, they consist, after the change, of an aggregate of minute particles of calc spar.* Artificial arragonite has been observed in the interior of a copper boiler used to supply hot water for household purposes at Port Eliot Cornwall. The crystals were minute six-sided prisms, and were attached at base to the surface supporting them.† Breithaupt has described a carbonate of lime from a greenstone rock near Zwickau, which consists of alternations of layers of arragonite and calc spar; and he suggests that the one may be a winter and the other a summer deposit.‡

"Dimorphism appears therefore to be owing to the different circumstances attending crystallization. Temperature appears to be the main cause; but it is possible that the nature of the solvent, or the presence of some accidental ingredient in the solution, or the electrical state of the support, may have some effect in changing the molecules; but in general the only effect of these causes is to produce secondary planes. Rose did not succeed in obtaining arragonite crystals by mixing a strontian salt with the solution of lime, and supposes that the strontia in arragonite has nothing to do with producing the rhombic form."

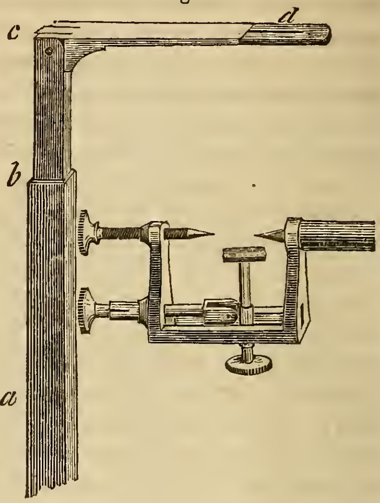
The foregoing views are worthy of the most careful attention, particularly in some cases, where their application has not heretofore been looked for. We might cite for instance the species

* Rose, Lond. and Ed. Phil. Mag. 3d ser. XII, 465.
† Lond. and Ed. Phil. Mag. 3d ser. XII, 330; 1841.
‡ Pogg. LI, 506; 1840.

Sillimanite, Kyanite and Andalusite, minerals chemically identical, but mineralogically considered, distinct.

Chapter IV, is on the determination of primary forms; we find under it the following figure and description of an ingenious and useful improvement in the reflecting goniometer of Wollaston, for adjusting the crystals; it is drawn from a German instrument.

Fig. 9.




The contrivance *acd* is also an important addition. It contains a slit at *d* for sighting the crystals, by using which, one of the lines may be dispensed with. It slides up and down in the part *ab*, and also moves back and forth, parallel with the plane of the graduated circle, on the pivot by which it is attached to the stand of the goniometer.

The chapter on *practical* crystallogeny is an interesting one, and largely illustrated by facts drawn from American sources. Crystallized minerals, especially when the individuals are large, are so rarely homogeneous in structure, that the attention of chemists (as before suggested, p. 367,) ought to be directed specially to a consideration of the circumstances under which the crystal was produced, before deciding definitely as to the essential nature of minute quantities of accidental ingredients, particularly if the mineral owes its origin to crystallization from solution. It seems probable from the observations of Beudant, that symmetrical crystals are seldom produced in clear or homogeneous solutions. Quartz, if pellucid and pure, is almost never regular or normal in the relation of its several secondary planes, while the highly ferruginous quartz, from Expailly, is always in regular bipyramidal prisms, although the quantity of foreign matter mechanically disseminated through the crystals, is such as to make them quite opaque. We see then the risk incurred in assuming that regularly crystallized *opaque* minerals are of course free from accidental impurities.

We might extract largely from this portion of the work with profit to our readers, but our space confines us, and we must refer for fuller details to the volume, now easily accessible to all. Under *crystallization by heat*, we find the following new and important observations, drawn from a practical source of the highest authority, and showing the importance of a close reunion between the theoretical and practical arts.

"It has been supposed that complete fusion is necessary for the formation of crystals, or the crystallization of a mineral mass. But late observations have shown, that a high temperature without fusion, or even long-continued friction or vibration, will produce the same result. The tempering of steel is a familiar example. The coarseness or fineness of the grain, or, in other words, the size of the crystallizations, may be varied by the temperature, or the mode of tempering, and a bar that is almost impalpably fine, may in this way be changed to one consisting of crystalline plates an eighth of an inch in breadth. In these instances, the particles must have been free to move, as they are entirely rearranged into large crystals. Mr. N. P. Ames, of Springfield, Mass., who has observed numerous interesting facts bearing upon this subject, informs the author that if a bar of tempered steel, bent in the form of a semicircle, be heated on the inner side, when the heat has reached a certain point, the bar may easily be bent around, and made to curve in the opposite direction. He states that, until the moment when the requisite temperature is acquired, the bar does not yield; but at this moment a change takes place, which is distinctly felt in the hands, and the bar at once bends. He carefully measured the inner and outer curves of the bar, after thus bending it, and found them of the same length as before. This shows that there had been no compression of the particles on the inner side, which would have shortened that side, and therefore, also, that there was actually a removal of particles from the inner to the outer side. He observes, moreover, that the elasticity of the inner and outer sides was the same, which would not have been the case, were the former compressed. By the old method of restoring a warped sword-blade, it was rendered unequally elastic, and would spring more easily on one side than the other; but by the means here explained, the elasticity is perfectly equal on both sides. Here, then, there is a change in the position of the particles throughout the bar, produced by a temperature very far short of fusion. The same experiment was often repeated, and he found that, at every time he bent the steel, the temperature required was a little above that at which it bent the preceding time.

"The change which takes place by friction or long-repeated concussion, is probably owing to the combined action of the heat thus excited, and the vibration that takes place. Mr. Ames states instances in which a large bar of iron, used as an axle through a heavy wheel of cast iron, broke square off in the middle, after use for a few months; and in one instance, there were two other fractures on either side of the centre. In these instances, the bar was rendered coarsely crystalline, and was wholly unlike the original iron. The accident which took place in 1842, on the Versailles railroad, was owing to the breaking of an axle, which was rendered brittle by the same cause."

The chapter on "blowpipe characters," contains in a tabular form the most important reactions of the principle oxides and earths with borax, salt of phosphorus and soda, being reduced from the works of Berzelius, Plattner, and others.

The much vexed question of *classification*, occupies the fourth part of the second section of the volume, and we extract the following judicious remarks on the subject, (p.128.)

"The arrangement of objects according to any assumed system, is styled a classification. By using different classes of characters to mark the grand divisions, various modes of arrangement may be made out. Of these there is one *natural* system; the rest are *artificial* classifications.

"Artificial classifications may sometimes be used to advantage for the convenience of comparison in identifying species; but farther than this, they only lead to error, by suggesting false affinities and unnatural associations of species. An arrangement of this kind is adopted in this treatise, founded on the crystalline forms. Excepting the purpose for which it is instituted—the determination of the names of minerals—it subserves no important end to the mineralogist; on the contrary, it brings together species the most unlike, and separates those most closely allied.

"The natural system is a transcript of nature, and consists of those family groupings into which the species naturally fall. In making out such a classification, instead of conforming the whole to certain assumed principles, the various affinities of the species are first ascertained, by studying out all their peculiarities and resemblances, and from these the principles of the system are deduced. There should be no forced unions to suit preconceived ideas, but only such associations as nature herself suggests.

"Unlike the other branches of natural science, mineralogy admits also of a *chemical* classification, or one founded on the chemical constitution of the species; and as minerals proceed from chemical instead of vital action, there is some reason for the adoption of chemical characters into the natural system. When the chemical relations of the elements are well understood, it is not too much to assert, that the *chemical* and *natural* systems will be identical.

"In the received chemical systems, analogies and affinities are very generally violated. Some authors arrange minerals according to the electro-positive element (the base) in their composition; and others follow the electro-negative element, (the acid:) and in both cases numerous difficulties obtain. The true system should conform to the one or the other, according to which is the characterizing ingredient; and on this plan, keeping in view also the principles of isomorphism, the chemical classification would not differ from the natural system.

"Carbonate of lime, carbonate of magnesia, carbonate of iron, and carbonate of manganese, are allied chemically—for their bases, lime, magnesia, oxyd of iron, and manganese, are isomorphous—and in physical and crystallographic characters they are also very similar. The group is therefore a natural one. The sulphates of several of the metals constitute a family of vitriols which are always associated in common language, and with equal propriety in science. But most chemical arrangements break up these natural groups, and place sulphate of iron (green vitriol) and carbonate of iron together under iron, sulphate of copper (blue vitriol) under copper, and so on. There is a natural group of alums, a potash-alum, soda-alum, magnesia-alum, &c., which is almost invariably broken up in the chemical systems, one placed with the salts of potash, another with the salts of soda, &c. A single species in mineralogy, pyroxene, is sometimes subdivided and distributed in various parts of the system. This species includes several distinct chemical compounds, as will be seen by referring to *Pyroxene*, in the descriptive part of the treatise; but they are so closely related physically, and, if we consider the isomorphism of the bases, we may say chemically also, that many *chemists* rank them in the same family. The micas evidently form a natural group, yet a chemist separates the rose mica from the others, and places it with other lithia minerals, because it contains a few per cent. of lithia. The natural family of the feldspars and the zeolites are usually broken up in the same manner. A few per cent. of the base will often lead to a dissevering of the closest affinities. The sulphurets of iron, copper, &c. form evidently a natural group chemically as well as mineralogically, yet, without reference to their relations, they are usually distributed under the different metals, although sulphur is here the characterizing ingredient. All the compounds of the metals are generally thrown together; whereas even chemistry, if its principles are well considered, would suggest that the salts of the various metals are in general more nearly allied than the salts and oxyds of the same metal. There can be no more unnatural association of species than the sulphate of iron, (green vitriol,) carbonate of iron, phosphate of iron, and specular iron. Titanate of iron and specular iron are isomorphous and similar physically, yet chemical systems would separate the two, and place the former along side of other salts of iron.

"Besides, various chemical compounds pass into one another by the gradual substitution of one isomorphous base for another, and although the extremes might be easily arranged in a chemical system, yet the transitions are disposed of with much difficulty. The augite family is a striking example.

"A true chemical system should take into consideration the isomorphous relations of the elements or bases, and not be subservient to any one set of characters. That element in the compound should be assumed for the ground of distinction, which fixes the peculiar features of the species—the acid in some species, the bases in others. In the vitriols, the acid (sulphuric) is the characterizing ingredient; in the alums, sulphuric acid and alumina; and so on. No chemical system can satisfy the demands of the science which does not follow nature's own windings. We would not say that the system of Mohs, adopted in this treatise as the natural system, is perfect; yet, whether we consider it chemically or mineralogically, it will be found to approach more nearly to such a system than any other that has been proposed."

The tables for determination of species are full, and original with the author. We find in the present edition a valuable addition to them—the degree of fusibility expressed in numbers after the manner of expressing hardness, and also a separate arrangement of the species without metallic lustre—according to their *blowpipe characters.* The minerals constituting the scale are, 1. *Gray antimony,*—2. *Natrolite,*—3. *Cinnamon stone,* (variety of garnet,)—4. *Hornblende,* (greenish-black variety,)—5. *Feldspar,*—6. *Chondrodite.* The last fuses with difficulty on the edges. *Infusibility* is expressed by 7.

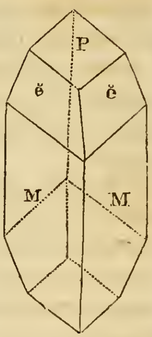
Descriptive mineralogy, (Part VI,) constitutes of course much the most bulky portion of the book. From what we have said of the elevated character of the introductory chapters of this work, the reader may infer that the descriptive part might have suffered in the hands of an author who valued so highly speculative and theoretical points. It will however be found, that great care and labor has been spent on this portion of the volume. No stone has been left unturned. The foreign journals and treatises have been ably collated; the species have generally been traced to their original authority and all the references authenticated, and those only who have wandered in the mazes of foreign authorities and foreign languages for the purpose in question, can fully appreciate the thankless nature of the labor. The number of species retained is about four hundred and eighty. By careful comparison of analyses, and by researches undertaken expressly for the work, some of the dark points of American mineralogy have been cleared up, and many species turned over to our table of synonyms on a following page.

This part of the work is well illustrated by figures, about seventy of which are new in this edition. The author has added many original figures of American species. We have space only to extract a few notices where the matter is new, and particularly interesting to American readers. We follow the order of the treatise.

"Borate of Lime. *Borocalcius obliquus.*

(*A. A. Hayes*, private communication to the author.)

Fig. 10.




"*Primary form*, an obtuse oblique rhombic prism; M : M=97° 30′ and 82° 30′—82° 36′, (Teschemacher.) *Secondary form*, the annexed figure; M : ĕ =147° 30′, (Teschemacher.) Also in masses having a globular form, consisting of interwoven fibres.

"Crystals colorless and transparent. Fibrous masses opaque, snow-white, silky, and have a peculiar odor.

"*Composition*, according to Mr. A. A. Hayes, *a Hydrous borate of lime;* the exact constitution has not yet been determined. In warm water the fibrous masses expand and form a consistent paste with more than eight times their volume. Mr. Hayes states that this variety contains more water than the crystals.

"*Obs.* This salt occurs quite abundantly on the dry plains near Iquique, S. A., associated with magnesian alum, (Pickeringite of Hayes,) where it was obtained by Mr. J. H. Blake. The crystals are sometimes a quarter of an inch long." (p. 243.)

"Chlorophyllite. *Stylus foliaceus.*

("Esmarkite, *Erdmann*, Jahresb. 1841, p. 174. Chlorophyllite, *Jackson*, 1st An. Geol. Rep. of New Hampshire, p. 152. Pinite.)

"Occurs in six and twelve-sided prisms. Highly foliated parallel to the base of the prism; sometimes also a prismatic cleavage more or less distinct.

"H. of basal plane 1·5—2; the lateral edges will scratch apatite. G.=2·705, Jackson; 2·709, Erdmann. *Lustre* of basal plane, pearly;

of lateral, pearly or greasy to imperfectly vitreous. *Color* green or greenish, greenish-brown—dark olive-green. Translucent to subtranslucent. Folia neither flexible nor elastic ; brittle.

" *Composition*, according to Jackson, (communicated to the author,) and Erdmann, (Jahresb. 1841, 174,)

| | *Chlorophyllite.* | *Esmarkite*, Brevig. |
|---|---|---|
| Silica, | 45·20 | 45·97 |
| Alumina, | 27·60 | 32·08 |
| Magnesia, | 9·60 | 10·32 |
| Protoxyd of iron,* | 8·24 | 3·83 |
| Protoxyd of manganese, | 4·08 | 0·41 |
| Water, | 3·60=98.32, J. | 5·49=98·10, E. |

" Traces of phosphoric acid were detected in the chlorophyllite.

" This mineral is closely allied to the hydrous iolite of Bonsdorff, but contains less water. Like that, it is found associated with iolite. Yields water before the blowpipe, and becomes bluish-gray, but fuses only on the edges. With carbonate of soda, effervescence takes place, and an opaque greenish enamel is formed, which becomes darker green in the reducing flame.

" *Obs.* Chlorophyllite is usually associated with iolite in granite, and appears to proceed from the alteration of iolite. It often forms thin folia interlaminated with plates of iolite in the hexagonal prisms of this mineral.

" The chlorophyllite of Jackson occurs abundantly in large prismatic and tabular crystals at Neal's mine in Unity, Maine, associated with hornblende rocks containing iron and copper pyrites. The same mineral occurs with iolite at Haddam, Connecticut, and has been called Pinite. The Esmarkite of Erdmann is found in granite near Brevig in Norway.

" The name Chlorophyllite, given this species by Dr. Jackson, is derived from χλωρος, *green*, and φυλλον, *leaf*, and alludes to its structure and color. The name Esmarkite was previously appropriated to a variety of Datholite.

" It is probable that both the hydrous iolite of Bonsdorff and chlorophyllite have proceeded from the alteration of iolite, and the hexagonal forms the crystals present may have been derived from the original iolite, instead of being the actual crystallization of the hydrous mineral. Gigantolite, Pinite, and Fahlunite, may also be altered forms of other minerals, and probably of iolite." (pp. 306, 307.)

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* If the iron in these analyses was *prot*oxyd, why should the sum of the alumina and iron be equal ? (35·91 and 35.84, diff. ·07.) We would suggest a query if it is not peroxide.—B. S., Jr.

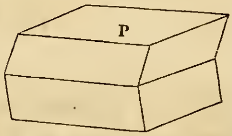
STELLITE.—This mineral has been described by Dr. Thomson,* and a mineral was mentioned by Dr. Beck in an article in this Journal, (Vol. XLIV, p. 54,) as identical with it, which has been found at Bergen Hill, and widely circulated under the name of Thomsonite. This mineral yielded to Dr. Beck's analysis,—silica 54·60, lime 33·65, magnesia 6·80, oxyd of iron with a little alumina 0·50, water and carbonic acid 3·20.

"Mr. A. A. Hayes has analyzed the same mineral with quite a different result, as follows:—Silica 55·96, lime 35·12, soda 6·75, potash 0·60, alumina and magnesia 0·08, protoxyd of manganese 0·64, water (hygrometric) 0·16=99·31. The large per centage of soda and the proportion of silica and lime, would seem to ally the species to *Pectolite*, from which, however, it appears to be removed by containing no water."

"The author has compared specimens of the stellite of Bergen Hill with the foreign pectolite in Mr. J. A. Clay's cabinet at Philadelphia, and finds them closely similar in external character; moreover, Frankenheim, in a late article, makes pectolite an anhydrous mineral, stating that the water varies, and is not an essential ingredient." (p. 336.)

HAYDENITE. *Chabazius monoclinatus.*—This interesting species is found in company with a rare and curious modification of Heulandite, which M. Levy has endeavored to establish as a distinct species under the name of Beaumontite, but which Mr. Alger has shown (this Vol. p. 233) to be Heulandite. The *Haydenite* was also *reëstablished* by Levy on crystallographic grounds, but as it is still doubtful whether its primary may not be a rhombohedron, like chabazite, instead of a rhombic prism, a chemical analysis was undertaken by B. Silliman, Jr., to settle the question. We copy the figure given by Mr. Dana, and from the appendix the chemical examination.

Fig. 11.




"*Primary form*, an oblique rhombic prism, (Levy.) M : M=98° 22′, P : M=96° 5′. *Cleavage:* lateral and basal, perfect; the latter little the most so. Twin crystals compounded parallel with P, as in the annexed figure.

"H.=3. G=2·136—2·265, (Silliman.) *Lustre* vitreous; bright. *Color* brownish-, greenish-, or wine-yellow. Translucent—transparent. Brittle.

"Dissolves partially without gelatinizing in sulphuric acid, and on cooling deposits crystals of alum. Fuses with difficulty before the blowpipe—tinges the outer flame violet. Heated in a glass tube alone, it gives off a slight empyreumatic odor, and deposits water.—(Silliman.)

* Outlines of Min. and Geol. Vol. I, p. 313.

"Composition,—

| | |
|---|---|
| Silica, - - - - - - - - | 56·831 |
| Alumina, - - - - - - - | 12·345 |
| Protoxyd of Iron, - - - - - - | 8·035 |
| Lime, - - - - - - - - | 8·419 |
| Magnesia, - - - - - - - | 3·960 |
| Potash, - - - - - - - | 2·388 |
| Water, - - - - - - - - | 8·905 |
| | 100·883 |

"*Obs.*—Haydenite was first described and named by Cleaveland. It has since been considered chabazite, and was lately restored to its place as a species by Levy. It occurs coating hornblendic gneiss in fissures at Jones's Falls, a mile and a half from Baltimore. The crystals seldom exceed a line in length, and are nearly rhombs in shape. They are usually coated with a brownish-green hydrate of iron, which is easily separated, and leaves the surface smooth and bright. Occasionally crystals are met with, consisting wholly of this hydrate of iron. The Haydenite is associated with Heulandite in minute crystals." (pp. 342, 526.)

This species seems to deserve a distinct consideration, notwithstanding its resemblance in some respects to chabazite.

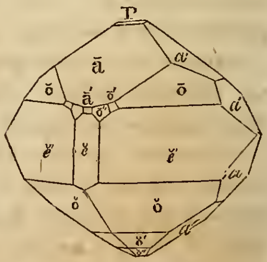
The iron was estimated as protoxyd from the excess found in the analysis, (103·355.) But there is reason to believe that the *lime* might have been in excess; allowing for this, and taking the iron as *peroxyd,* the formula will be

$$(\dot{Ca}, \dot{Mg}, \dot{K})\dddot{Si} + (\dddot{\mathbf{Al}}, \dddot{\mathbf{Fe}})\dddot{Si}^2 + 3\dot{\mathbf{H}},$$

which is the formula given for some chabazites, (from Parsborough, see Dana's Mineralogy, p. 559,) excepting half the proportion of water. The analysis as it stands leads to the less probable formula—

$$6(\dot{Ca}, \dot{Mg}, \dot{K}, \dot{Fe})\dddot{Si} + 2\dddot{\mathbf{Al}}\dddot{Si}^2 + 9\dot{\mathbf{H}}.$$

Fig. 12.



Under *Datholite* we have the accompanying figure of a rare and interesting form of this mineral from the new locality of Roaring Brook, Cheshire, Conn. (p. 342.)

Epidote.—Haddam, Conn., furnishes crystals of this species having the form shown in fig. 13. Some of the individuals from this locality are six to eight inches in length, and always macles.

Idocrase.—Amherst, in New Hampshire, furnishes the form represented in fig. 14.

Andalusite.—A crystal of Andalusite from Westford, Mass., shown in fig. 15, was measured by Mr. Teschemacher, P : a 144·50.

Fig. 13.

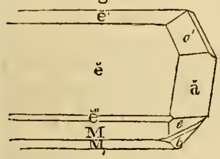


Fig. 14.

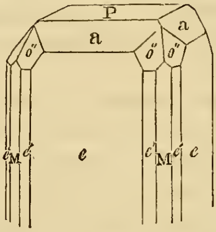
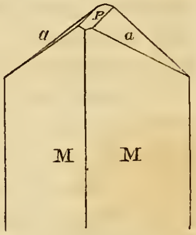


Fig. 15.




Chondrodite.—We have at last a figure and the angles of this rarely crystallized species as follows, (Fig. 16.)

"*Primary form*, an oblique rhombic prism; M : M=112° 12′? Haüy. *Secondary form:* M : M=112° and 68°, M : ĕ=136°, M : ē=157°, ĕ : ĕ (adjacent)=80°, *a* : *a* (over the summit)=85°, ē : ē=89°, ĕ : ē (over *a*)=127°, ă on the edge ĕ : ĕ=167. The figure is drawn from a specimen in the collection of J. A. Clay, Esq. of Philadelphia. The angles were taken with the common goniometer." (p. 388.)

Fig. 16.

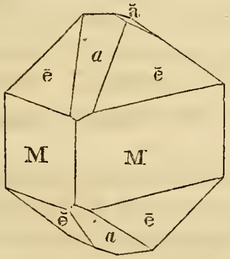
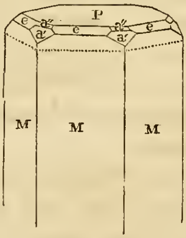


Fig. 17.



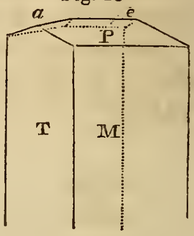
Beryl.—The beautiful and almost unique beryls from Haddam, described by Prof. Johnston (in this Journal, Vol. xl, p. 401) are rarely modified by secondary planes. Fig. 17 shows one with the planes a′ a″ and e. The dotted line marks the boundary between the pellucid and milky portions.

Sillimanite. *Epimecius Sillimanianus.*

This interesting mineral has been the subject of much speculation. The following figure and angles are taken from a specimen in the cabinet of B. Silliman, Jr. and found at Norwich, Ct.

" *Primary form*, an oblique rhombic or rhomboidal prism; M : T=110° to 98°, crystals having the faces M smooth and plain, give the latter, which therefore appears to be the correct angle of the prism. *Secondary form*, the annexed figure; P : M=105°, P : ĕ=133° 30′, M : e=120° 30′, P : *a*=132°, (D.) The terminal planes dull and hardly smooth. *Cleavage* highly perfect, parallel to the longer diagonal, and producing brilliant surfaces; parallel to M indistinct. Crystals usually long and slender. Occurs also long fibrous, parallel, or slightly divergent.

Fig. 18.




" H.=7—7·5. G.=3·2—3·238, D.; 3·259, Norton. (Yorktown.) *Lustre* vitreous, inclining to pearly; hardly shining on M, but splendent on the face of perfect cleavage; parallel to P, vitreous, inclining to resinous. *Streak* white. *Color* hair-brown—grayish-brown. Translucent. *Fracture* uneven, parallel to P. Brittle. The long crystals are detached from the rock entire, with great difficulty, on account of their frangibility.

" *Composition*, according to Bowen, (Sill. Jour. VIII, 113,) Muir, (Thom. Min. I, 424,) Connell, (Jameson's Jour. XXXI, 232,) and Norton, performed for this work, in the laboratory of B. Silliman, Jr.

| | Chester, Conn.* | Chester. | Chester. | Yorktown, N. Y. |
|---|---|---|---|---|
| Silica, | 42·666 | 38·670 | 36·75 | 37.700 |
| Alumina, | 54·111 | 35·106 | 58·94 | 62·750 |
| Zirconia, | | 18·510 | | |
| Oxyd of iron, | 1·999 | 7·216 | 0·99 | 2·287 |
| Water, | 0.510 | | | |
| | 99·286, B. | 99·502, M. | 96·68, C. | 102·739, N. |

" The analyses by Connell and Norton show that this mineral contains no Zirconia.

" Before the blowpipe, both *per se* and with borax it is infusible.

" *Obs.* The crystal here figured appears to have dissimilar lustre on M and T, and this, as well as the secondary planes, indicates that the primary is probably a *rhomboidal* prism. In composition, Sillimanite is very close to Kyanite, if they are not identical; yet its bright and easy cleavage shows that it is mineralogically distinct from that species." (pp. 377, 378,)

Connell proposed (Jameson's Jour., Vol. XXXI, p. 232) the union of Sillimanite with Kyanite, and Berzelius† in his report for this

* Chester, Ct. is quoted in Thomson and other foreign authors as Saybrook, Ct.

† Arsberte Kemi och Min. (Swedish edition,) 1843, p. 202.

year, suggests the union of Sillimanite, Kyanite,* and Andalusite, under the general formula $\dddot{A}l^3\,\dddot{S}i^2$. There are strong reasons for believing that silicate of alumina is a dimorphous substance, and on this supposition we may consider Sillimanite one of its forms. *Mineralogically* Sillimanite is certainly distinct.

Iolite.—We have the following analyses of Iolite from Haddam, Ct. and Unity, in New Hampshire, by Dr. Jackson. (p. 406.)

| | Haddam. | Unity, N. H. |
|---|---|---|
| Silica, . . . . . | 48·35 | 48·15 |
| Alumina, . . . . | 32·50 | 32·50 |
| Magnesia, . . . . | 10·00 | 10·14 |
| Protoxyd of iron, . . . | 6·00 | 7·92 |
| Prot. manganese, . . . | 0·10 | 0·28 |
| Water, . . . . . | 3·10 | 0·50 |
| | 100·05 | 99·49 |

Ilmenite.—"The *Washingtonite* of Shepard, a variety of Ilmenite, has been analyzed by J. S. Kendall in Dr. C. T. Jackson's laboratory, and found to contain titanic acid 25·28, peroxyd of iron 51·84, protoxyd of iron 22·86=99·98. It appears therefore to be nearly identical in composition with the hystatic iron ore of Breithaupt, or the *Hystatite* variety of this species." (p. 527.)

If we were to form our estimate of the progress of American mineralogy by taking into view the number of exploded species of American minerals only, we should be forced to conclude that such *progress* was of rather an equivocal nature. But we must bear in mind that the science is burthened with hundreds of synonyms of European minerals which still hold a place in the index of the present work, while too many of the bad American species have been proposed by *foreign* authors. There can be no objection to giving the following alphabetical list of American species which have been proposed and subsequently abandoned. The list is made out from our own opinions, and it is too much to expect that it will meet in all cases the views of authors.

* The Kyanite from Chesterfield in Massachusetts, has been recently analyzed by one of my pupils, (Mr. C. H. Rockwell of Norwich.) The specimen was finely crystallized, transparent, and azure colored: it yielded

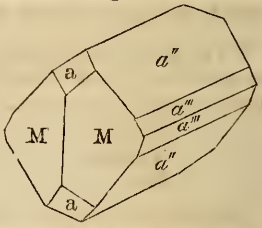
| | |
|---|---|
| Silica, - - - - - - | 42·74 |
| Alumina, - - - - - | 57·90 |
| Iron, - - - - - - | trace. |
| | 100·64 |

This analysis adds farther confirmation to the views expressed in the text.—B. S., Jr.

| Names proposed. | Authors. | Identical with. |
|---|---|---|
| Acadiolite, | Thomson, | Chabazite. |
| Baltimorite, | Thomson, | Picrolite, or fibrous serpentine. |
| Beaumontite, | Levy, | Heulandite. |
| Brucite, | | Chondrodite. |
| Bytownite, | Thomson, | Scapolite ? |
| Calstronbaryte, | Shepard, | Mechanical mixture of calc spar, strontianite, and heavy spar. |
| Catlinite, | Jackson, | A clayey rock, and not a mineral. |
| Chiltonite, | Emmons, | Prehnite. |
| Cleavelandite, | Brooke, | Albite. |
| Danaite, | Hayes, | Mispickel.* |
| Deweylite, | Emmons, | Serpentine. |
| Danburite, | Shepard, | Mechanical mixture of silicate of lime and quartz. |
| Edwardsite, | Shepard, | Monazite. |
| Emmonsite, | Thomson, | Impure strontianite. |
| Eremite, | Shepard, | Monazite. |
| Eupyrchroite, | Emmons, | Mammillary apatite. |
| Fowlerite, | | Manganese spar. |
| Gymnite, | Thomson, | Impure serpentine. |
| Hudsonite, | Beck, | Variety of pyroxene. |
| Jeffersonite, | Keating, | Pyroxene. |
| Ledererite, | Jackson, | Gmelinite, var. Chabazite. |
| Lederite, | Shepard, | Sphene. |
| Lincolnite, | Hitchcock, | Heulandite. |
| Marmolite, | Nuttall, | Serpentine. |
| Maclurite, | | Chondrodite. |
| Masonite ? | Jackson, | Foliated hornblende ? chloritoid ? |
| Microlite, | Shepard, | Pyrochlore ? |
| Mullicite, | Thomson, | Vivianite. |
| Nuttallite, | | Scapolite. |
| Peristerite, | Thomson, | Feldspar. |
| Perthite, | Thomson, | Feldspar. |

* Mr. Teschemacher (in Dr. Jackson's Report on the Geology of New Hampshire, p. 167) has given a figure of "Danaite" with the following angles; M : M=112°; a : a=121° 30′, $a''$ : $a''$=100° 15′, (see the annexed figure, which is Teschemacher's figure inverted in position so as to correspond with the usual figures of Mispickel.) Scheerer has described a similar cobaltic variety from Skutterud, which gave the angles M : M=111° 40′—112° 2′, a : a=121° 30′. The angles do not differ essentially from those of Mispickel. Rammelsberg considers iron and cobalt isomorphous, and gives for the formula of the species Mispickel, (Fe, Co)($S_2$, $As_2$). (See pages 475, 476 and 568 of Dana's Mineralogy.)

Fig. 19.



| Names proposed. | Authors. | Identical with. |
|---|---|---|
| Pickeringite, | Hayes, | Magnesian alum. |
| Polyadelphite, | Thomson, | Brown garnet. |
| Raphitite, | Thomson, | Hornblende ? |
| Rensselaerite, | Emmons, | Steatitic pyroxene or pseudomorphous steatite. |
| Retinalite, | Thomson, | A doubtful serpentine compound. |
| Scoharite, | Macneven, | Heavy spar, with 6 to 9 per cent. of silica mechanically mixed. |
| Stellite, (of Bergen hill,) | | Pectolite. |
| Terenite, | Emmons, | Doubtful—altered scapolite or augite. |
| Tephroite, | Breithaupt, | Troostite. |
| Torrelite, | Thomson, | Columbite from Middletown, Ct. |
| Torrelite, | Renwick, | An impure red jasper. |
| Washingtonite, | Shepard, | Ilmenite. |
| Xanthite, | Mather, | Idocrase. |

*Catalogue of American localities and minerals.*—This is one of the many novel features of the present edition. Besides full and minute specifications of American localities under the several species, we have them here arranged geographically, beginning with Maine and following the coast. This list is designed to aid the mineralogical tourist in selecting his routes and arranging the plan of his journey.

"In making out this catalogue, the names of those minerals which are obtained in good specimens at the several localities, are distinguished by italics. When the specimens are remarkably good, an exclamation mark (!) has been added, or two of these marks (!!) when the specimens are quite unique. If a locality that has afforded peculiarly fine specimens is now exhausted, the exclamation mark has been inverted (¡). The more exact position of localities may in most instances be ascertained by reference to the description of the species in the preceding part of the treatise."

*Chemical Classification*, Part VII.—We have already extracted (p. 374) the author's views, in which the strictly chemical character of the arrangement adopted in the Treatise is explained. The following additional remarks are cited from the introduction to a *second* classification by the author, corresponding more nearly with other chemical arrangements. Speaking of the natural system, he says:

"It takes into view, it is true, the external characters; but as these depend upon the chemical constitution, and proceed from it, they are indications of the composition, and unless followed too implicitly and without a general survey of the whole subject, will not lead to important variations from a strict chemical method. It has been shown that owing to the isomorphism of bases, the old modes of chemical classification are wholly unsatisfactory; and the difficulties have of late become so great that some authors have fallen into an alphabetical arrangement, rather than be bound down to the usual chemical rules. Moreover, it has been remarked, that the union of the salts of metals into a family is more correct on chemical principles than a distribution of them under the several metals: and that as the salts of lime, magnesia, alumina, are also salts of metals, the former fall naturally and chemically into close associations with the latter, as in the system adopted.

"Yet it is convenient to the chemist and to the metallurgist, to view the ores of the several metals by themselves, and in general to be able to survey at a glance the compounds of each element. For this purpose, the following classification has been made out. Except in the metallic ores, the mineral species have been kept together, as much as possible, in natural families, by taking into consideration the isomorphous relations of the elements; and it is believed that the classification here proposed will be found to combine many of the more important advantages of both systems. *Chemists* treat of the alums as a family, of the various feldspars as another, and the varieties of hornblende and augite another, and so on; and instead of scattering them in the different parts of a system, as was formerly done, arrange them together and treat of them as distinct groups, although differing so much in chemical constitution. These natural families are still retained in the method of arrangement here brought forward."

To this table are added the chemical formulas for composition, derived from the most recent authorities.* The chemical symbols, inasmuch as they speak more directly to the eye, have been adopted in preference to the mineralogical, although printed with more difficulty.

The author has ingeniously substituted the black type (**H**, for example) in place of the crossed letters used by Berzelius for double atoms.

An example of these new symbols for expressing a double dose of base, is given in the formula for *Haydenite* in the present article. It has the great advantage of being easily followed and imitated, while the type introduced by Berzelius can only be had at the expense of punches and matrices expressly made for the

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* Particularly from Rammelsberg's Handwörterbuch der Chemischen Theils der Mineralogie; 2 vols. 8vo. pp. 442 and 326: Berlin, 1841:—And, Erstes Supplement, (first supplement to the same,) 8vo. pp. 156: Berlin, 1843. This supplement is to be continued biennially.

purpose. We have found it impossible to procure the type of Berzelius even in London, ready made. Probably it is owing to this difficulty that these useful symbols have been so slowly introduced out of continental Europe. The double type gives instant notice of the double base, and we shall hereafter employ them in this Journal.

We may add that the mineralogical cabinet of Yale College has been recently arranged, nearly, on this plan. The tabular arrangement of these formulas secures many advantages not attained when they are distributed through the volume each under its species.

*Rocks and mineral aggregates.*—Part VIII. of this volume is devoted to a description of the various mineral aggregates which form the rock masses of our planet. It is not usual to include these in a mineralogical treatise, nor are they treated here in any other than a mineralogical way. There is an expectation on the part of most general readers of finding, when they take up a mineralogical book, an account of the principal rocks, and when they search the index in vain for such words as porphyry, granite, basalt, and the like, they very naturally feel a degree of disappointment. This chapter is intended to meet that expectation. Its arrangement presents at every step the same admirable power of generalization and order which so eminently distinguish all the author's works.

The work is brought to a close by a mineralogical bibliography posted up to the present time: in it are registered all the important publications on the subject, from Theophrastus down, and in the American portion, every paper on the subject, which has been published, even in a transient magazine, is recorded. The student in his researches will duly appreciate the value of this unpretending catalogue. Nor must we fail to mention the *index*, the key to technical knowledge, and which is in the present case most satisfactorily full and comprehensive; every known name and synonym ever used in the science is introduced.

But we must abruptly close this notice, already too long, with the remark, that it gives us pleasure to believe that it requires but few works like the present, to give *American science* a name, which will merit, if it does not receive, the respect of the scientific world. B. S., Jr.

Art. XXI.—*Abstract of the Proceedings of the Thirteenth Meeting of the British Association for the Advancement of Science.**

The thirteenth meeting of this noble institution was held at Cork, Ireland, commencing on the 16th of August last, and continuing its sessions until the 23d. The British Association was instituted in September, 1831, and reports of its proceedings, more or less in detail, have been regularly given in this Journal. The present abstract of the transactions of the last meeting should have accompanied our preceding No. but was excluded by the pressure of important communications, the insertion of which had been previously promised; and the crowded state of our pages compels us now to omit many valuable and interesting papers, and to confine ourselves to abridged reports of some of those subjects which fall more appropriately within the scope of this Journal.

The general meeting was on Thursday evening, August 17th, when the annual address, on the objects and results of the Association, was delivered by the President, the Earl of Rosse.

From the Report of the Treasurer it appeared, that the receipts from June 23d, 1842, to August 14th, 1843, amounted to £3271 4*s.* 4*d.*, including a balance on hand from the previous year of £538 14*s.* 6*d.* The expenditures amounted to £2775 3*d.*

At the meeting of the General Committee, Col. Sabine read the Report of the proceedings of the Council during the past year, from which we take only the interesting item, that application had been made to Government to undertake the publication of the Catalogue of Stars in the Histoire Céleste of Lalande, and of Lacaille's Catalogue of the Stars in the Southern hemisphere, which has been reduced and prepared for publication at the expense of the British Association; and that Her Majesty's government had given the necessary directions for issuing £1000 for the completion of the work in question.

Grants of money for the prosecution of the objects of the Association, were recommended by the General Committee, to the amount of £1877—of which £1007 were appropriated to the Physical Section, and £650 of this latter sum to Mr. Baily, for the publication of the British Association Catalogue of Stars. Among the recommendations not involving pecuniary grants, we notice, that Prof. Bache be requested to proceed with his report on American meteorology.

It was unanimously resolved, that the next meeting of the Association should be held at York, in the course of September, 1844,—the

* Condensed from the Report in the London Athenæum.

particular day to be designated by the London Council. The Rev. J. Peacock, Dean of Ely, was elected President of the next meeting.

Section A. *Mathematical and Physical Science.*

Rev. Dr. Robinson presented a Report, by Mr. Baily, from the Committee appointed to prepare *the British Association Catalogue of Stars*, from which it appeared that the reduction was complete. He proceeded to explain the value of this catalogue by stating, that among the heavenly bodies the stars are generally considered as motionless, and were used as points of comparison for their more erratic companions. In this respect, an accurate determination of their places is of high importance; but it becomes still more interesting from the fact, that we know many of them to be in motion, so that it is difficult to find one absolutely fixed, and the research of their proper motions becomes matter of great interest. This is effected by comparing their places observed now, with those accurately determined at a former epoch. To do this, is not so simple as might at first sight appear. In the first place, we do not see the star in its true place; the motion of light makes it to be observed in advance of that, as the earth moves. Secondly, it is referred to the pole or equinox: these points are not fixed in space; the one is influenced by the action of the sun and moon—the other moves with irregular precessions by the same force, and that of some of the planets. The observed place must therefore be corrected for aberration, mutations, &c. before it is of any use, and the mean of several such mean places, gives the desired result. This is very troublesome, and was often loosely performed, till Mr. Baily published the Catalogue called by the name of the Astronomical Society, containing about 2800 stars, and which changed the history of Stellar Astronomy. Formerly from 30 to 40 stars, called standard, were observed, and the rest overlooked; so that in an emergency of a comet, or an occultation, there was often no reference possible, and direct observations of the individual object were requisite. Its great advantage is—the system of logarithms computed for each star gives, with extreme facility, the corrections above described. But their numbers change with the changes of the stars' places, so that already they require an alteration. The advantages of this work were such, that the Association thought no greater service could be rendered to astronomy than the extension of Mr. Baily's catalogue. It now contains nearly 10,000 stars, and the secular changes of the constants are given with them. Besides, in the places of the stars there is an important improvement; the places in the former catalogue were derived from a comparison of those given by Bradley for 1745, and Piazzi for 1800: whatever error was in either of these, was multiplied by the mode of computation when brought up to 1830; but this fault was, in the present instance, corrected.

"*On Elliptic Polarization of Light reflected from various substances*," by Prof. Powell. The author had previously stated, that among other results connected with this subject, he had observed the phenomena of elliptic polarization in polarized light reflected from several mineral substances, in which it had not been (as far as he was aware) hitherto noticed. This inquiry bears upon the general question—to what substances is the property of converting plane into elliptic vibrations, in the reflected light, confined? As far as observation has yet gone, it seems restricted, in general, to *metallic* substances, whether pure or compound; but to this there seem to be some exceptions, and it remains to be determined, what *proportion* of metal, in a compound, is necessary to produce the result.

Prof. Kane read a paper, by Prof. Draper of New York, "*on a Change produced by Exposure to the Beams of the Sun, in the Properties of an Elementary Substance*." Chlorine gas, which has been exposed to the daylight or to sunshine, possesses qualities which are not possessed by chlorine made and kept in the dark. It acquires from that exposure, the property of speedily uniting with hydrogen gas. This new property of the chlorine arises from its having absorbed tithonic rays, corresponding in refrangibility to the indigo. The property thus acquired is not transient, like heat, but permanent. A certain portion of the tithonic rays is absorbed, and becomes latent, before any visible effect ensues. Light, in producing a chemical effect, undergoes a change, as well as the substance on which it acts: it becomes detithonized. The chemical force of the indigo ray is to that of the red, as 66·6 to 1. Our acquaintance with the constitution of elementary bodies is still imperfect; inasmuch as, in general, only those properties are known which they possess after having been subjected to the influence of light.—Dr. Robinson stated, what seemed to him confirmatory of Prof. Draper's views as to the distinction between the *tithonic* and luminous rays, that he had been induced to think the Daguerreotype might give very exact representations of the inequalities of the lunar surface. Having procured the apparatus, a plate prepared by Claudet's process was exposed, in the place of the image of a Cassegrainian reflector, of 15 inches aperture. The intensity of the light was such, that when the image of the crater Copernicus, one of the brightest in the moon, came into the field of view, it dazzled the eye; but though the telescope was carried by a clock-movement of extreme precision, after an exposure of half an hour there was shown, after mercurializing, but a faint and indistinct image, or rather trace. Another plate, similarly prepared, gave, in half a minute, on a cloudy day, a most perfect picture of his house, in which minute details were shown by the microscope. Dr. R. inferred, that as the heat accompanying the solar rays was not found in the light of the moon, being probably absorbed there, so these other rays were also absorbed, though possibly in a less degree. The apparent complementary relation between the color of chlorine and that of the ray which seemed to have the highest power, was curious, and excited a wish to know if any thing similar occurred in respect of the vapor of iodine, or if this power was confined to the blue end of the spectrum.

"*On the Regular Variations of the Direction and Intensity of the Earth's Magnetic Force*," by Prof. Lloyd. The observations (made at the Dublin Magnetical Observatory) were commenced early in the year 1839, and have been continued, almost without interruption. Since the beginning of the year 1840, they have been taken every two hours, day and night. The elements directly observed are the *declination* and the *two components* (horizontal and vertical) *of the intensity*, and from the variations of the latter, those of the *total intensity* and *inclination* are readily deduced. The variations were projected in curves, which represented the course of the mean daily changes for the entire year, for the summer and winter half years, and for each month separately.

*Declination.*—The mean daily curve of the changes of declination for the entire year exhibits a small easterly movement of the north end of the magnet during the morning hours, which reaches its maximum about 7 A. M. After that hour, the north end moves rapidly westward, and reaches its extreme westerly position at 1*h.* 10*m.* P. M. It then returns to the eastward, but less rapidly, the easterly deviation becoming a maximum about 10 P. M. The mean daily range =9·3 minutes. During the summer months the morning maximum at 7 A. M. is more marked; the evening maximum, on the contrary, disappears, there being a slow and regular movement of the north end to the eastward from 7 P. M. until 7 A. M. In winter, on the other hand, the evening maximum is well defined, and the morning maximum disappears, there being a slow and regular westerly movement until 9 A. M., after which the movement becomes more rapid in the same direction. The epoch of the extreme westerly position of the magnet is nearly the same throughout the year. The greatest daily range, in summer, is about 13·7 minutes; the least range, in winter, about 7·2 minutes.

*Horizontal intensity.*—The mean daily course of the horizontal force, for the entire year, has two maxima and two minima. The first minimum occurs between 1 A. M. and 3 A. M., which is followed by a maximum about 5 A. M., or a little after. These fluctuations are small. A second and principal minimum takes place at 10*h.* 10*m.* A. M.; and a second, or principal maximum, about 6 P. M. The mean daily range =·0024 of the whole intensity. In the summer months the smaller maximum and minimum disappear, the intensity decreasing continually throughout the night, but slowly, until 5 or 6 A. M., after which the decrease becomes rapid. There are, consequently, but one maximum and one minimum in the mean daily curve, which corresponds nearly in epoch with the principal maximum and minimum of the curve for the entire year. In the winter months, on the other hand, there are three maxima and three minima, the evening maxima appearing to break into two. The epoch of the morning maximum moves forward as the time approaches the winter solstice, appearing to depend upon the hour of sunrise, which it precedes by a short interval. The epoch of the principal minimum is nearly constant throughout the year. The daily range is greatest in the month of July, when it is about ·0045 of the whole intensity; it is least in the month of January, being then about ·0008 of the whole.

*Total intensity and inclination.*—The total intensity appears to vary very little throughout the day. It seems to be least about 9 A. M., and then to increase, attaining a double maximum in the afternoon. The total range, however, being very small, the variations of the two components of the intensity are dependent chiefly upon the changes of the inclination. The inclination is greatest between 10*h.* and 10*h.* 30*m.* A. M. and least about 6 P. M., the epochs corresponding with those of the least and greatest values of the horizontal intensity. The daily range is about two minutes in the early part of the year, and increases to more than double of that amount in summer. If we combine the changes of declination and inclination, the former being multiplied by the cosine of the absolute inclination, we obtain the whole movement of the north end of the magnet in free space, or the curve formed by the intersection of the magnetic axis with the sphere whose radius is equal to unity. The whole movement during the first six hours of the day is inconsiderable. It appears, on a review of these facts, that the diurnal changes in the direction of the magnetic force are (as might be expected) connected with the diurnal movement of the sun, and its times of rising and setting. The changes of the intensity appear to be influenced in addition by some other cause, or by the same cause operating less directly.

Prof. Wheatstone made a Report on *the Electro-Magnetic Meteorological Register*, constructed for the observatory of the British Association, which was represented as nearly complete. It records the indications of the barometer, the thermometer, and the psychrometer, every half hour during day and night, and prints the results, in duplicate, on a sheet of paper in figures. It requires no attention for a week, during which time it registers 1,008 observations. Five minutes are sufficient to prepare the machine for another week's work; that is, to wind up the clock, to furnish the cylinders with fresh sheets of paper, and to recharge the small voltaic apparatus. The range of each instrument is divided into 150 parts; that of the barometer comprises three inches, that of the thermometer includes all degrees of temperature between —5° and +95°, and the psychrometer has an equal range.

"*On a remarkable Photographic Process, by which dormant pictures are produced capable of development by the breath or by keeping in a moist atmosphere*," by Sir J. F. W. Herschel. If nitrate of silver of specific gravity 1·200, be added to ferro-tartaric acid of specific gravity 1·023, a precipitate falls, which is in a great measure redissolved by a gentle heat, leaving a black sediment, which being cleared by subsidence, a liquid of a pale yellow color is obtained, in which a further addition of the nitrate causes no turbidness. When the total quantity of the nitrate solution added, amounts to about half the bulk of the ferro-tartaric acid, it is enough. The liquid so prepared does not alter by keeping in the dark. Spread on paper and exposed *wet* to the sunshine (partly shaded) for a few seconds, no impression seems to have been made, but by degrees, although withdrawn from the action of the light, it develops itself spontaneously, and at length becomes very intense. But if the paper be thoroughly dried in the dark, (in which state it is of a very pale greenish yellow color,) it possesses the singular property of receiving a dormant, or invisible picture; to produce which (if it be, for instance, an engraving that is to be copied) from thirty seconds to a minute's exposure in the sunshine is requisite. It should not be continued too long, as not only is the ultimate effect less striking, but a picture begins to be *visibly* produced, which darkens spontaneously after it is withdrawn. But if the exposure be discontinued before the effect comes on, an invisible impression is the result, to develope which all that is necessary is, to breathe upon it, when it immediately appears, and very speedily acquires an extraordinary intensity and sharpness, as if by magic. Instead of the breath, it may be subject to the regulated action of aqueous vapor, by laying it in a blotting-paper book, of which some of the outer leaves on both sides have been dampened, or by holding it over warm water. Many preparations, both of silver and gold, possess a similar property in an inferior degree, but none to the extent of that above described.

Dr. Robinson read a paper, "*on the Barometric Compensation of the Pendulum.*" At the Manchester meeting of the Association, (1842,) Prof. Bessel made a communication on the improvement of the Astronomical Clock, which, with other valuable matter, contained a proposal to compensate for the changes of rate produced by the varying density of the atmosphere. Dr. R. would not have adverted to the subject, did he not think that a method proposed and applied by him twelve years ago, possessed certain advantages over that of the illustrious astronomer of Königsberg, which entitle it to the preference in practice. As early as 1825, he had ascertained the fact, that the received buoyancy correction was too small, by comparing the rates of a transit clock with the barometric indications; and Col. Sabine gave the final proof of it by swinging the pendulum in a vacuum apparatus, in 1829. The amount of it is far from inconsiderable; even with the mercurial pendulum of a transit clock, weighing 21 pounds, and presenting a very small surface, it is $0^s{\cdot}36$ for an inch change of the barometer. The remedy is obvious: by attaching a barometer to the pendulum, its fall transfers a cylinder of mercury from a point near the axis of motion to a greater distance from it; the time of vibration may thus be made to increase by the same amount that it decreases in consequence of the diminished density of the air. By placing the clock *in vacuo* as Bessel proposes, (and as Sir James South has actually done for several years past,) the effect of resistance can be determined exactly, and the *diameter* of tube selected, which will nearly correct it. The diameter selected by Dr. R. (0·1 inch) is not far from the truth. In the autumn of last year, when the temperature was nearly stationary, a fall of 1·6 inch produced *no appreciable change of arc.*

"*On Contoured Maps*," by Captain Larcom. It is important that governmental maps should exhibit the levels of the country in the most intelligible manner; showing heights not merely on the tops of hills, but around their sides, and through the valleys which traverse them. Such a system is offered by these contours. They are a series of horizontal lines, at a certain distance asunder, and at a certain height above a fixed datum. The datum most commonly used is the level of the sea, doubtless from the shore line being the limit of the land, and the point at which roads must cease, as well as from an impression that it is itself a level line; and therefore, as the first contour, the most appropriate and natural zero, from which to reckon the others. It has been a point much discussed, whether the high water, the low water, or the mean state of the tide, offers the most level line. Capt. L. stated that, in order to determine it, as far as Ireland is concerned, a series of lines has been very accurately levelled across the island in various directions, and permanent marks are left in all the towns, and on numerous public buildings; and at the end of each of these lines on the coast, tidal observations have been made every five minutes during two complete lunations. These observations, and the connecting lines of level are now in process of reduction—the degree of accuracy attained is such, that a discrepancy of ·2 of an inch is immediately apparent—and from them we may expect many points of interest. The steeper the natural slope of the ground is, the closer together, of course, the contours will be, and the more oblique the road; where, on the contrary, the ground slopes very gently, the contours are farther asunder, and the road may be proportionally more direct.

The Rev. Prof. Lloyd read a paper, by Rev. T. Knox, "*on the Quantity of Rain which falls in the S. W. of Ireland, and in Suffolk, Eng-*

*land, with the wind at the several points of the compass.*" The instrument employed in these observations, (made at Toomavara in the county of Tipperary, and at Monk's Eleigh in Suffolk, by Rev. T. Knox and Rev. H. Knox,) was contrived by the Rev. T. Knox, for the purpose of registering the amount of rain which falls at a given place with the wind in different points of the compass. The observations embrace a period of one year, and the results, expressed in inches, are given in the following table.

| | S. | S.W. | W. | N.W. | N. | N.E. | E. | S.E. | Total. |
|---|---|---|---|---|---|---|---|---|---|
| Toomavara, | 4·249 | 12·696 | 8·150 | 2·640 | 3·115 | 3·078 | 3·101 | 3·523 | 40·552 |
| M. Eleigh, | 2·674 | 2·756 | 1·371 | 2·392 | 2·776 | 2·027 | 3·092 | 1·708 | 21·796 |

It appears, that while the total amount of rain which falls in Tipperary is nearly double of that which falls in Suffolk, there is likewise a wide difference between the two stations as to the quantity which falls with different winds. In fact, nearly one third of the whole amount falls at the Irish station during the prevalence of southwesterly winds; while, at the English station, there is a much nearer approach to equality in the amount of rain borne by different winds. This prevalence of rain with the southwesterly wind, is distinctly marked in every season of the year at the Irish station; while in Suffolk each season is characterized by an excess of rain from a different point of the compass, producing a near approach to uniformity in the results of the entire year. These results, it is to be observed, are integral effects; and a comparison of them with the times of continuance of the respective winds, gives the *raininess* (if it may be so called) of the several winds.

"*An Account of an extraordinary Tide at Arbroath,*" by Mr. Brown. The ordinary neap tide at Arbroath rises from eight to nine feet, but on July 5th, 1843, an extraordinary phenomenon occurred. The moon was in perihelion at 2 o'clock, and the evening tide was suddedly raised, at the time of high water, to nine and a half or eleven feet—again sunk for about ten minutes, and was raised again, there being a series of fluxes and refluxes. It was not known whether the phenomenon commenced with a rising or a depression, or with the horizontal length of the wave. The sea was perfectly calm, but vessels which were entering the port perceived a current stronger than usual. In the evening there was a violent thunder storm. Persons who had observed the appearance before, accounted for it on the supposition of a storm in the Atlantic from the southwest.—Mr. Scott Russell thought the phenomenon at Arbroath was not tidal at all. Similar phenomena had been observed elsewhere, on the coast of Scotland, and are described in the same manner. It is supposed by some that they are the consequences of the subsidence or elevation of the coast; others think that they arise from submarine volcanic explosions, and the undulations of the atmosphere which were observed immediately after, would seem to strengthen this opinion.

Mr. Hunt called attention to a peculiar condition of the tide on the 5th of July, at Mount's Bay, Cornwall. The tide had receded for about half an hour, when it was observed to flow again, and continued to do so for about ten minutes, when it again receded. This was three times repeated. It was observed that this took place over an extensive line of coast, from Land's End to Port Leaven.

Section B. *Chemistry and Mineralogy.*

"*Chromatype, a new Photographic Process*," by Mr. R. Hunt. While pursuing an extensive series of researches on the influence of the solar rays on the salts of different metals, Mr. H. was led to the discovery of a process by which positive photographs are very easily produced. Several of the chromates may be used in this process; but those of mercury or copper are preferable—the most certain effects being produced by the chromate of copper, and, indeed, in a much shorter time than with any of the other chromates. The papers are thus prepared: good writing paper is washed over with a solution of the sulphate of copper and partially dried; it is then washed with a solution of the bichromate of potash and dried at a little distance from the fire. Papers thus prepared may be kept for any length of time, and are always ready for use. They are not sufficiently sensitive for use in the camera obscura, but they are available for every other purpose. An engraving—botanical specimens and the like—being placed upon the paper in a proper photographic copying frame, it is exposed to sunshine for a time, varying with the intensity of light from five to fifteen or twenty minutes. The result is generally a negative picture, which, being washed over with a solution of nitrate of silver, a very beautiful deep orange picture upon a light dun color, or sometimes perfectly white ground, is immediately produced. This picture is quickly fixed, by being washed in pure water and dried. If saturated solutions are used, a negative picture is produced; but if the solutions are diluted with three or four times their bulk of water, the first action of the sun's rays is to darken the paper, and immediately a very rapid bleaching action follows, giving an exceedingly faint positive picture, which is brought out in great delicacy by the nitrate of silver. It is necessary that pure water should be used for the fixing, as the presence of any muriate damages the picture, and hence arises another pleasing variation of the chromatype. If the positive picture be placed in a very weak solution of common salt, the images slowly fade out, leaving a very faint negative outline. If it be taken from the solution of salt and dried, a positive picture of a lilac color may be produced by a few minutes' exposure to sunshine. Prismatic analysis has shown that the changes are produced by a class of rays which lie between the least refrangible blue, and the extreme limits of the violet rays of the visible prismatic spectrum—the maximum darkening effect being produced by the mean blue ray, whilst the blackening effect appears to be produced with the greatest energy by the least refrangible violet rays.

Mr. Hunt also made a communication "*on the Influence of Light on the Growth of Plants.*" The peculiar influence exerted upon the germination of seeds and the growth of the young plants by colored light, has been for some years the subject of the author's investigations. The results show the surprising powers exerted by the more luminous rays in preventing germination, and in destroying the healthful vigor of the young plant. Plants, when made to grow under the influence of the red rays, bend from the light as something to be avoided; while the blue or chemical rays are efficacious in quickening their growth. It has however been found that although blue light accelerates germination, and gives a healthful vigor to the young plant, its stimulating influences are too great to ensure a perfect growth. The strength of the plant appears to be expended in producing a beautiful deep green foliage; and it is only by checking this tendency, by the substitution of a yellow for a blue light, that the plant can be brought into its flowering and seeding state. The etiolating influence of the green rays was noticed, as well as the power which plants possess of sending out shoots of a great length in search of that light which is essential to their vigor.

Dr. Andrews in a paper "*on the Heat of Combination,*" announced the general principle: "When one base displaces another from any of its neutral combinations, the heat evolved or abstracted is always the same when the base is the same; or, in other words, the change of temperature which occurs during the substitution of one base for another in any neutral compound, depends wholly on the bases, and it is in no respect influenced by the acid element of the combination." To test the accuracy of this principle by direct experiment, equivalent solutions of various neutral salts were decomposed by the addition of a dilute solution of the hydrate of potash. When the strength of the solutions and their temperatures were properly adjusted, the same variation of temperature always occurred during the decomposition of salts of the same base. If the base (in the state of a hydrate) developed, when alone, less heat than the hydrate of potash in combining with the acids, an elevation of temperature occurred during the decomposition of its salts by the latter; if the reverse were the case, the decomposition of the salts was attended by a diminution of temperature. Thus the decomposition of equivalent solutions of the salts of the oxide of copper, was attended by the evolution of the same amount of heat, as was also the decomposition of the salts of the oxide of zinc ; but the heat extracted by the former was about twice as great as that extracted by the latter, because the oxide of copper produces less heat in combining with the acids than the oxide of zinc. The salts of lime furnish an example of an absorption of heat when their solutions are decomposed by potash,—a circumstance easily explained by the fact before established, that the hydrate of lime, when combining with the acids, develops more heat than the hydrate of potash. But, in accordance with the principle above stated, the diminution of temperature is the same with equivalents of all the salts of lime. In an inquiry of this kind many precautions are requisite, in order to obtain accurate results. Among the most important may be mentioned, the exact neutrality of the salt to be decomposed, a perfect equality of temperature in the solution before mixture, and the precipitation of the oxide in the state of a pure hydrate, and not of a subsalt.—Prof. Kane thought it highly probable that the law propounded by Dr. Andrews will eventually be judged by chemists to be the most important communication made to this Section. He also observed, that if we mix an atom of oil of vitriol with an atom of water, a considerable degree of heat is developed. Now, the concentrating of this dilute acid was not simply a case of evaporation, but one of decomposition ; and it would appear that the same quantity of heat was necessary to effect that decomposition as was developed during the combination.

Mr. West read a paper "*on a remarkable case of Corrosion of Lead by Spring Water, after passing through an Iron Pipe.*" The water of a spring, which had flowed into and from a leaden reservoir for sixty years without injury to either, and which passed through leaden pipes without metallic impregnation, when further conveyed a long distance, through iron pipes, contained lead in solution, and was so destructive to the bottoms of the leaden cisterns, into which it next flowed, that some of them had to be renewed in five or six years. Mr. West stated the analyses of the water in question, which, except as to the lead, were the same when taken from all the three situations : he imputes the mischief to contact with oxides of iron from the pipes, and considers that the remedy must be mechanical, by coating the iron pipes or the leaden cisterns with some other substance, so as to preserve the lead itself from contact with peroxide of iron.

"*On the Decomposition of Carbonic Acid Gas, and the Alkaline Carbonates, by the Light of the Sun,*" by Prof. Draper of New York. The decomposition of carbonic acid gas, by the leaves of plants under the influence of the light of the sun, is one of the most remarkable facts in chemistry. Dr. Daubeny, in a very able paper in the Transactions of the Royal Society for 1836, came to the conclusion, that the decomposition in question was due to the rays of *light*, a result obtained by the agency of colored glasses, but which does not appear to have been accepted by later authors, who have attributed it to the chemical rays. There is but one way by which the question can be finally settled, and that is by conducting the experiment in the prismatic spectrum itself. When we consider the feebleness of effect which takes place, by reason of the dispersion of the incident beam through the action of the prism, and the great loss of light through reflection from its surface, it would appear a difficult operation to effect the determination in this way. Encouraged however by the purity of the skies in America, Dr. Draper made the trial, and met with complete success. The process was as follows:—a series of tubes, half an inch in diameter and six inches long, were arranged so that the colored spaces of the spectrum fell on them. In these tubes, water, impregnated with carbonic acid gas, and containing a few green leaves, (Poa annua,) was placed. It was expected, that if the decomposition be due to the radiant heat, the tube occupying the red space, or even the one in the extra-spectral red space, would, at the close of the experiment, contain most gas. If it were the "chemical rays," in the common acceptation of the term, we might look for the effect in the blue, violet, or indigo spaces; but if it were the *light*, the gas should make its appearance in the yellow, with some in the green, and some in the orange. I made the trial several times, (says Dr. D.) and found it much more easy to accomplish than I had expected. The results were briefly as follows:—In the tube that was in the red space a minute bubble was sometimes found, but sometimes none at all. That in the orange contained a more considerable quantity; in the yellow ray a very large amount, comparatively speaking; in the green, a much smaller quantity; in the blue, the indigo, the violet, and the extra-spectral space at the end, not a solitary bubble. From these facts, in connection with some results obtained by the use of bichromate of potash, as an absorptive medium, I conclude that it is the rays of light which effect the decomposition, and that the rays of heat and the tithonic rays have nothing to do with the phenomenon. The alkaline bicarbonates are easily decomposed by elevation of temperature, yielding a portion of their acid at the boiling point of water. Instead of using a solution of carbonic acid I endeavored to effect the decomposition of these salts by leaves in the sunlight, and found that it took place with facility. Nor is the effect limited to the removal and decomposition of the second atom of the acid. It passed on to the first; the neutral carbonate of soda itself decomposing and yielding oxygen gas. In like manner, the sesquicarbonate of ammonia may be made to yield a very pure oxygen gas. Dr. Draper, in conclusion, alluded to his method of multiplying the Daguerreotype pictures, as published in the Philosophical Magazine, and mentioned a process of precipitating copper, after the picture has been fixed by gold, by the electrotype process, on the plate, which gives a very perfect copy. "It would be difficult," he says, "to describe in words the beauty and perfection of these '*copper-tithonotypes.*' The problem of multiplying the Daguerreotype may be now regarded as completely solved."—Prof. Apjohn made a few remarks on this communication, which announced results so different from our received ideas on this subject, it being generally agreed that the chemical rays were the most active in producing the decomposition of the carbonic acid absorbed by the plant.—Mr. Hunt said, that he had listened with great surprise to Dr. Draper's paper, as, from his own experiments with colored glasses and transparent media, carefully analyzed so as to determine what rays were absorbed, and what rays passed through them, he had arrived at conclusions diametrically opposed to those now put forth. He acknowledged that he had never tried the experiment with the pure rays of the prismatic spectrum, but he should certainly lose no time in doing so, on his return to England.

Dr. Tamnau, of Berlin, exhibited some rare *mineralogical specimens:* 1. A group of Datholite from the neighborhood of Andreasberg, in the Hartz. 2. Two specimens of rose-colored Harmotome from Andreasberg. The color in these specimens was attributed to the presence of a small quantity of cobalt. They were remarkable for the great size of their crystals, which exhibited not only the usual twins, but also curious and complicated arrangements of three and four, combined according to laws not yet sufficiently understood to allow of their being clearly described. 3. Two very large isolated crystals of Beryl, from Royalston, Mass. These were of a beautiful sea-green color, one of them of the usual form, a regular six-sided prism, with the direct terminal face. The other exhibited the faces of the second six-sided prism, of a twelve-sided prism, and of a twelve-sided irregular pyramid.

"*On the Production and Prevention of Smoke,*" by Mr. Henry Dircks. Mr. D. thought it important to distinguish between open fires and close fires and furnaces. Open fires would always allow an escape of absolute coal gas, and admit atmospheric air to the chimney; whereas the contrary would be the result with the close fires of the engine-boiler furnaces. He said that the leading fact of consequence, in reference to the smoke, was, that it differed materially from the impure gas evolved from the coal in the furnace. The plans hitherto adopted by manufacturers were chiefly intended to burn *smoke*, and the great principle of all such plans was to burn the largest quantity of fuel with the least quantity of air. The error of this method must appear to every one conversant with chemistry. Smoke may be considered as mere carbonaceous matter floating in an atmosphere of the ordinary incombustible products of combustion; the admission of air to this smoke is of no value, as it will only cool it, and make it more readily deposit its sooty particles. The impure gas of the coal, on the contrary, may be inflamed by a due admixture of air. In conclusion, Mr. Dircks stated a general principle, that on the large scale of the furnace, air should be applied to the impure gaseous products of the fuel by a source independent of that supplying air by the ash-pit to the solid fuel.

It was recommended by the General Committee, that the future title of this Section be "Chemistry and Mineralogy, with their application to Agriculture and the Arts."

[The remainder of our Abstract we are reluctantly compelled to defer until the July No.]

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## MISCELLANIES.

1. *Analysis of Meteoric Iron from Burlington, Otsego Co., N. Y.*—Dr. L. C. Beck, in his report on the mineralogical survey of New York, p. 383, makes mention of a mass of malleable iron, said to be native, which he saw in the cabinet of the Albany Institute. It does not appear that any chemical examination was made of the mass.

Last November, Mr. E. C. Herrick, being in Geneva, N. Y., received from the hands of Prof. James Hadley of that place, a mass of metallic iron, which Prof. H. assured him was a portion of the same specimen mentioned by Dr. Beck in his Report above quoted, and that both belonged to a larger mass, which when found was supposed to weigh from one hundred to two hundred pounds avoirdupois. Mr. Herrick also learned, that Dr. Eli Pierce of Athens, N. Y. was the gentleman who originally communicated the specimens and information to Dr. Hadley.

On Mr. Herrick's return to this place, the mass was placed in my hands for examination. Its strong resemblance to the iron found in North Carolina, by Prof. Olmsted, (this Journal, Vol. XVII, p. 140,) and examined subsequently by Prof. Shepard, (Vol. XL, p. 369,) immediately struck me; it was divided by broad laminæ, crossing each other at angles of 60° and 120°, cutting up the surfaces into triangular and rhombohedral figures. It broke with a hackly fracture and only with the greatest difficulty, on the thinnest edges.

Two deep and broad sutures marked its two most regular and opposite faces, made by the wedge or chisel by which the blacksmith (into whose hands the larger mass unfortunately came) severed it from the adjoining portion. It bore the marks of having been intensely heated in the smith's forge, and numerous microscopic crystals, of a black color and brilliant lustre, covered some parts of its surface. They resembled phosphate of iron, but were too small to be detached. I had no doubt on first seeing the mass, of its extra-terrestrial origin, which opinion was confirmed by the following analysis performed in my laboratory by Mr. C. H. Rockwell, one of my pupils.

It dissolved quickly and completely in pure nitric acid, with the application of a gentle heat. The solution tested with nitrate of silver gave no cloudiness, showing the absence of chlorine. Still farther to settle the question, of the presence of chlorine, the mass was put in a clean capsule and placed over a water bath, covered on the plate of an air pump by an air-tight jar. After exposure to this humid atmosphere for a week, it was taken out and washed with pure water into the capsule, which contained also water of condensation from the mass. These washings, tested with nitrate of silver, remained quite unclouded. After the heat to which the mass had been subjected in the smith's forge, it could hardly be expected that we should find any traces of chlorine, if it ever existed. The solution of the iron in nitric acid yielded, with the usual process for separating iron from nickel,

| | |
|---|---|
| Metallic iron, - - - - - | 92·291 |
| Do. nickel, - - - - | 8·146 |
| | 100.437 |

No traces of other substances could be detected in the iron. Specific gravity 7·501.

With a view to obtain all the information possible in relation to this interesting meteoric iron, Mr. Herrick addressed a letter of inquiry to Dr. Pierce, which brought the following particulars. He says: "In the year 1819, I procured some two or three masses of native iron (as it appeared to be) from the farmer who first turned it over with his plow, in a field near the north line of the town of Burlington, Otsego Co., N. Y. These consisted of remnants of an entire mass originally supposed to weigh between one and two hundred pounds, and found several years before. Before I had any knowledge of its existence, it had been in the forge of a country blacksmith, and the whole heated in order to enable him to cut off portions for the manufacture of such articles as the farmer most needed. The smith assured me that he never worked stronger, tougher, or purer iron; that it made the best horse-shoe nails. All the fragments that remained I immediately secured, and presented them to Prof. Hadley, whose lectures I was then attending. These were in two or three irregular masses, in all some eight to twelve pounds, with the marks of the chisel used in cutting while in a heated state. In conversation with the farmer who found the original mass, I could only learn that in plowing the field he found a stone very heavy, rusty on the top, which lay above the surface. From its great specific gravity, he was induced to examine more particularly, and thinking it might be iron he carried it to his blacksmith, who, finding it iron, had worked up the most of it into horse-shoes, nails, &c., as the farmer needed. The latter told me that he had seen several small specimens of what appeared to be similar, whilst plowing the same field, but a diligent search made by me at the time proved fruitless in discovering any other specimens, the field being at that time in meadow.

" It was the opinion of Prof. Hadley, on the first examination, that it was of meteoric origin. Why it was not completely buried in falling, may be accounted for by the fact, that the ground on which it was found was hard and strong. Yours, &c. E. PIERCE."

Measures have been taken to secure as much of this interesting mass as can now be obtained, for the mineralogical collection in Yale College.

B. SILLIMAN, Jr.

Yale College Laboratory, March 20, 1844.

2. *Improvements in Cambridge, England.*—We are permitted to mention the following facts, in the language of Prof. Adam Sedgwick, contained in a letter, dated May 2, 1843, and addressed to Prof. Romeo Elton, late of Brown University, Rhode Island.

" The Cambridge Philosophical Society continues to flourish, although with perhaps less vigor, since Prof. Airy, now Astronomer Royal, ceased to live amongst us. It has published seven volumes, which (without vanity) I may be allowed to praise; as of late years I have not been a contributor to them. We rejoice to be in communication with men and societies of pursuits similar to our own. Seventeen years have made a great change, at least in our external appearance; and should we again have the pleasure of seeing you in Cambridge, we could I trust show you much that is both new and interesting. We have now a noble museum of comparative anatomy, and a geological museum worthy of the University, at the growth of which I do greatly rejoice, as I regard it as my own child and offspring. The Fitzwilliam museum, chiefly devoted to the fine arts, painting, sculpture, antiquities and works of literary luxury, is now nearly finished and is externally a noble work of architecture. Time has made sad inroads on my health and strength; I have some works on hand which I now almost despair of finishing, and I give up all hopes of a tour in North America, with which I long delighted to indulge my fancy."

May heaven grant to this noble explorer of nature, and eloquent commentator on her works, restored health, long protracted usefulness and honor; and the power as well as the disposition to cross the Atlantic; for, no foreign philosopher would be greeted with a more cordial welcome, and with more zealous and efficient aid in his scientific explorations.

3. *Association of American Geologists and Naturalists.*—This body holds its sixth annual session in the city of Washington, commencing on Wednesday the 8th* of May, at 10 A. M. The central position of the place of meeting, with the growing importance of the Association, it is believed will secure a full and interesting meeting; while the efforts made by the standing committee will conspire to the same end.

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*Our miscellany and notices of new books* are necessarily abridged in the present number, owing to the pressure of original and longer communications.

We are sensible that a fuller review of foreign science is expected at our hands, and that the majority of our readers prefer more condensed abstracts of foreign matter and miscellaneous communications, and it will be our endeavor hereafter, to give more fullness to this department of the Journal.

Among the new books which we have received, and of which notices are deferred to a future number, are

*Memoirs of William Smith, LL. D., author of "the map of the strata of England and Wales."* By his nephew and pupil, John Phillips, F. R. S., F. G. S. London, John Murray, 1844. 8vo. pp. 150.

*Geology, Introductory, Descriptive, and Practical.* By David Thomas Ansted, M. A., F. R. S., G. S., &c. &c. London, February, 1844. J. Van Voorst. 8vo. Part I, pp. 128. To be completed in eight monthly parts, uniform with the zoological works of Messrs. Bell, Forbes, and Yarrell, and the British Fossil Mammalia of Prof. Owen.

*A History of British Fossil Mammalia and Birds.* By Richard Owen, F. R. S., F. G. S., &c. &c. Part I, 8vo. 5*s.* sterling each. The work will be completed in eight or ten monthly parts. Van Voorst, London.

*Experimental Researches, Chemical and Agricultural, showing Carbon to be a compound body, made by plants and decomposed by putrefaction;* by ROBERT RIGG, F. R. S. London, Smith, Elder & Co., 65 Cornhill, 1844. 12mo, pp. 364.

*Appendice a Tous les Traités d'Analyse Chimique*, &c. &c. Par C. Barreswil et A. Sobrero. Paris, Avril, 1843. Fortin, Masson et Cie. 8vo. pp. 547. $1.75. A most valuable book.

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* Erroneously stated in the secretary's circular of invitation to be the 10th.

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# APPENDIX

TO THE AMERICAN JOURNAL OF SCIENCE AND ARTS, VOL. XLVI, NO. II.

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## EDITORIAL REMARK.

When a controversy turns on the discussion of principles or facts, promoting the advancement of science—or when an author makes reclamation of discoveries original with himself, and either through ignorance or intention appropriated by another—the pages of the American Journal of Science are freely open to a calm and candid exposition of the case. When however, as in the present instance, *science is no longer* the theme of discussion, and the arguments regard wholly the respective personal characters of the disputants, and their reputation for veracity, we feel that we transgress the bounds of editorial propriety by forcing upon the attention of our readers, matter in no wise interesting beyond the limited circle of acquaintances of the several parties, and in excluding from our pages papers which are the appropriate contents of a Journal of Science. On these grounds we have determined to incur the expense of an appendix, not necessarily a part of the Journal, and which subscribers can at their option retain or reject when the work is bound. We have further, with the knowledge of Mr. Couthouy, submitted a proof of his "Review" to his antagonist, that no excuse might exist for another communication from either, and we take this opportunity publicly to inform the parties interested, that this controversy will not again be permitted, under the covers of this Journal.

Editors of Am. Jour. Science.

March 15, 1844.

## *Review of and Strictures on Mr. Dana's Reply to Mr. Couthouy's Vindication against his charge of Plagiarism;* by Joseph P. Couthouy.

At the time when I submitted to the public through the medium of the American Journal, my reply to the charge of plagiarism preferred against me by Mr. Dana in the number for July, 1843, I presumed that the subject would be permitted to rest until the approaching meeting of the Association of American Geologists and Naturalists, at which I had solemnly pledged myself to substantiate by indisputable testimony the statement contained in that reply.

As Mr. Dana, however, has deemed it advisable to follow up the question during the interval by the publication in the last number, of several pages of comments upon my vindication, and has in these comments not only misstated actual facts, but most unwarrantably misrepresented the language of my defence, in order as I have just right to infer, to give greater force to his assertions, and has also brought several new issues before the public, besides repeatedly, either by direct charge or by implication, impugning my honor and veracity, I feel constrained by a regard for these, which are as dear to me as Mr. Dana's are to him, reluctantly to intrude again upon your pages in a matter now strictly personal between us.

In doing this I shall be as brief as consistent with a clear presentation of the facts, and avoid any thing like the "vituperative language," which Mr. Dana by insinuation intimates I have been guilty of.

I will proceed therefore to review Mr. D.'s statements in the order of their appearance, at least such of them as require any notice at this time. On p. 130 he remarks, "The public have cause for regret that Mr. C. did not bring forward at once the abstract of his journal sent home from Sydney, which is said to contain the views in dispute, as many words might possibly have been saved, if the facts are as stated; and it would have borne down with more force than all his dozen pages of argument. But for some reason this was kept behind. A few particulars respecting this abstract might be added here, but are better reserved until some personal accusations are disposed of."

The object of Mr. D. in this plausible sentence is too obvious to require comment, but it is based wholly upon a gratuitous assumption of the nature of the documents in question. There never was any '*abstract*' of my journal sent home from Sydney, nor have I ever intimated that such was the case; consequently, however the public may regret it, no such 'abstract' could have been brought forward. My statement, p. 380, Vol. XLV, Jour., is as follows. "I transmitted by sure hand, to some friends in Boston, duplicate minutes of the most important of my observations from the time of our leaving the United States, to our arrival at Upolu, in the Samoan group." Even had these 'minutes' been a connected 'abstract,' it is obvious, from the period through which they extend, that it would be impossible to present them to the public through the pages of any Journal. But the truth is, they are scattered in disjointed fragments through some 1400 pages of MSS, of which nine tenths are records of strictly personal views and feelings, intended only for the eyes of those nearest and dearest to me. Such abstract as could be made, had in fact already been 'brought forward,' in the very article which has given rise to this discussion; and it will be in evidence of its authenticity that I shall submit to the Association the documents from which it was compiled. I know not in what way I could have acted more fairly and unreservedly than I have done in this matter.

On same page (130) he continues, "Mr. Couthouy complains of unfairness in my not addressing him before making the charge public, and dwells upon the intimacy between us at sea, in order to bring out in bolder colors, this 'misused confidence.'" I unqualifiedly deny this intention. I have in no part of my reply, charged Mr. D. with having "misused confidence" in the matter at issue. Again, p. 135, "My readers are probably satisfied that I have not 'misused confidence.'" Allow me to repeat the remark on pp. 387–388, Vol. XLV, in my reply, which is thus misapplied. "I may hereafter take occasion to show that he (Mr. D.) has availed himself of them (my notes) in a manner that leaves him, *to say the least*, equally open with myself to the charge of having misused confidence. My first duty will be to fully vindicate myself from the accusations he has brought against me. When this shall be accomplished, it may then be Mr. D.'s turn to act on the defensive." I apprehend that your readers will be *better* able to judge in relation to Mr. D.'s having 'misused confidence,' or, in *my* language, laid himself open to the charge of having done so, when the charge shall have been made by me, and met by Mr. D.

On p. 131, Mr. D. professes to clear himself from my charge of discourtesy in having attacked me without notice or remonstrance at my presumed injustice towards him, by stating, that after waiting ten months in expectation of receiving a copy of my article on coral formations, or of hearing from me on the subject, and neither of these occurring, he considered himself under no obligation to address me on the subject, choosing to impute my silence to a consciousness of having done him wrong. What that man's friendship is worth, who could place such a construction upon a matter so easily explained in many other less injurious ways, I leave others to say. In the mean time I will state the simple cause of this, to Mr. D.'s mind, suspicious silence on my part. When the Expedition returned to our shores, I was stationed at Washington, where, soon afterward, I rejoiced to meet with Dr. Pickering and Mr. Rich. Almost my first inquiry was for Mr. Dana. They could not inform me where he could be addressed, but presumed that with all the others, he would soon be in the city. Mr. Drayton soon after came on, but he was also ignorant of Mr. Dana's whereabout. To each of these gentlemen I gave a copy of my article. Had Mr. Dana visited Washington as was expected, I should have hastened to place one in his hands also, with a full statement of my reasons for publication. Indeed, a copy must have been marked for him at the time, since I find his name on my list of those to whom it was distributed. I gave myself no further trouble at that time, being told by the judge advocate that Mr. Dana would, with all the other members of the corps, be present at the approaching court-martial in New York; and there I had no doubt of meeting him. In this I was disappointed, as Mr. Dana did not attend the trial. I heard, however, that he had been at New Haven, on a visit to the Editors of this Journal, and presuming that he had there seen the article in question, as I had transmitted them a copy, I thought no more of the matter, still intending to give one to Mr. D. when we met. In the latter part of the ensuing August, or early part of September, while in Boston, engrossed with making arrangements for entering into my present business, I heard, by accident, that Mr. D. had been for several days in the city, but had then left. I felt grieved and angered that he should have done this—especially when I remembered how during a visit to Western New York the year previous, I had put both myself and a friend who was travelling with me to considerable inconvenience, that I might be able to call upon his family, and convey to them the pleasure of receiving tidings of their relative, from one who had parted from him only a few months before. Prior to our sailing, also, I had welcomed Mr. Dana to my house, and shown him every attention in my power. And now he had left the city without even making me a passing call. Without the remotest suspicion that any thing published by me was the cause of this unfriendly procedure, I attributed it in my bitterness to the motives which too often lead men to turn a cold shoulder to those whom they were once glad to call friends. I was in disfavor with the clique then controlling the collections of the Expedition; I was shut out from any share in the publication; it was best to have no further connection with me, as nothing more was to be gained by it. I can truly say, I rejoice that this was *not* the true cause of Mr. D.'s conduct, though at the time I could imagine no other, and presume also it will be admitted that I have given a very natural explanation, at all events a true one, of the reasons why Mr. D. did not hear from me touching my publication. Soon after this, the cares and duties of a new business so fully engrossed my time and thoughts, as to leave me neither leisure nor inclination to pursue my original intention of addressing Mr. D. a note of inquiry on the subject, and I dismissed it as I supposed, forever from my mind. A word more on this head and I have done with it. It was I that at the meeting of the Association in Boston, nominated Mr. Dana for admission to membership, prefacing the nomination with remarks expressive of all I then felt toward him. Did this, I would ask, 'betoken a consciousness' of having wronged him?

"What shall we say," exclaims Mr. D., and his coadjutor or familiar, whose claim to a share in the paternity of his reply, appears more than once in its pages in the significant *we* and *us*,—"what shall we say of the honorable feelings which * * * * could trespass also on the department of a friend, for he has given to the public numerous geological facts observed abroad, besides those on coral islands? What of the honesty which could find any excuse for transmitting home duplicate minutes of his journal, contrary to express prohibition by the authority under which we sailed?" To the first of these questions I answer, it is untrue that I have given to the public such numerous geological facts as Mr. D. therein represents me to have done, although as I shall prove, repeatedly urged and even told it was my duty to do it, by men whose high sense of honor and strict justice Mr. D. dare not question. I have never published a line on geological subjects other than what is contained in my article on coral formations, in which there is not a single fact but has a direct bearing on that topic, and the publication of that article was entirely incidental and unpremeditated, expanding under my hands to an extent far beyond my original idea, which was simply to point out an erroneous statement by Mr. Lyell, in regard to the structure of the reefs bordering Tahiti. One remark suggested another, till, unconsciously to myself, the intended note swelled into the essay which has given rise to this unpleasant controversy.

As to the honesty of my 'transmitting home duplicate minutes,' &c., I will say that I acted under the best advice within reach, and were I so circumstanced again I would do the same thing. Had not the great mass of what was sent been of a most strictly private and personal character, containing much on which no stranger's eye should rest, I should have forwarded them to the department instead of to my family. I now rejoice more than ever that this was not done. Cut off by circumstances from any control over my MSS. there deposited, I could not suppose that the unblushing violators of the sanctity of a private seal would respect it any the more for being placed on a private journal; and no man living would care to have the pages, in which he had laid bare the inmost recesses and given vent to the deepest emotions of his heart, subjected to the criticisms and heartless sneers of such as would in all probability have access to them.

It was the apprehension of a fate like this befalling those pages, in case of my never leaving Sydney, which caused me to send them home, as before remarked, under an injunction to be kept strictly private,—and I believe there are few men living, who, if situated as I was, would not have done the same. But this is not the point at issue between Mr. D. and myself.

The same remark applies to all his arguments, touching my accuracy or inaccuracy in giving 76° as a flourishing temperature. At a proper time and place I shall notice these, but they are wholly extraneous to the present question. I may be wrong or I may be right in my views, but this has nothing to do with the question whether I have borrowed certain other views from Mr. Dana. There are one or two passages however which must not be passed over in silence. On p. 133 Mr. D., speaking of my article on coral formations says, "He states that through the coral archipelago to the eastward of Tahiti, the surface temperature ranges from 78° to 81°, (Bost. Jour. p. 75.) The fact is that the range is from 77° to 83°, and in the second part of his article, printed at a later period, we find this range given, (p. 100*) evidently a correction of the former, and not a part of his expedition observations."

This is indeed a very suspicious circumstance, if the facts so complacently here set forth by Mr. D. are correct. Unfortunately for his conclusions, and for the inferences he wishes the public to make from them, the second part of my article was *not* printed as he asserts, at a later period than the first. The entire article was set up and printed simultaneously, as it appeared in the extras printed for my use, which came out at the close of December, 1841, in anticipation of the publication in the Journal. It was divided at the request of the publishing committee, in order to make room for other communications, which had been promised an insertion in the number containing the first part of my paper. Moreover, the correction alluded to, was made precisely because having between the early and latter part of the article, had my journal returned by a friend to whom it had been loaned, I found on reference to my *Expedition observations* that my first statement, from memory, did not exactly correspond with them, since at Clermont Tonnerre, the maximum temp. for 24 hours was 78° and the minimum 77°, and the same off Serle I., while off an island near Raraka, to which the name of King's I. was given at the time, its range was from 78° to 83°.† The only information not derived from my own observations, was that on the temperatures at Callao, Valparaiso, in November, the Gallapagos, Trinidad, C. Verde Is., Martin Vas and Fernando Noronha, which, as stated p. 382 of last volume of this Journal, I derived from the appendix to King and Fitzroy's voyage.‡ I might, if

* Page 160 is meant.

† In reference to these variations, I will cite from my article in Bost. Journ. Vol. IV, p. 155, the following sentence. "At a future day I may be enabled (abandoning the indefinite specifications whose occurrence I am well aware is too frequent in these remarks, but which under the circumstances are unavoidable,) systematically to arrange my observations, and give the details with the minuteness and precision demanded by the importance of the subject."

‡ I perceive that by an oversight in the text, I have said, "from the same work and at the same time were derived all the local temperatures of the Pacific, specified in my article." It should have read, "all the local temperatures of places not visited by me in the Pacific, or not visited at the seasons specified in my article," as implied by the reference to p. 160 Bost. Journal, in foot-note, p. 382 last volume of this.

space and time permitted, here annex a table of the daily maximum and minimum oceanic temperatures between the entrance of the squadron upon the Paumotu group and its arrival at Tahiti, in support of the views advanced in my article, but it is better perhaps to defer it for the present, as the Association will meet so shortly.

On p. 135, to which, with a view to save time, I refer the reader, Mr. D. specifies what he is pleased to call a very apparent instance of equivocation, a (for me) most unfortunate change in the idea—and adds, "We may reasonably hesitate before we give full credit to the statements of one who will so prove false to his own writings."

Now I assert in regard to this, that the equivocation is entirely Mr. D.'s, and utterly deny that I have in any instance proved false to my own writings, or falsified my opponent's. It were well for him could he with equal truth say as much. Where I remark, in my vindication, p. 385, "where that exists is 'the field of their most lavish display,'" I refer to the temperature of the bottom. This is *expressly* stated in an antecedent sentence on the same page, 385, and immediately following, is the *very passage quoted by Mr. D.*, from the Boston Journal, "among the Paumotus, the field of their most lavish display, the temperature varies from 77° to 83°," and to this is appended a foot-note expressly declaring *these* temperatures to be those of the *surface!* I ask the readers of this Journal to reperuse this passage in my vindication, and decide whether my language has not been pitifully distorted, to fasten on me this charge of equivocation. But this is far from the most glaring instance of Mr. D.'s shameful perversion of my expressions. I will pass over, for the present, the cool manner in which he meets my charge of having accused me of making before the Association statements borrowed from his MSS., by merely saying that he was led into error, but this matters little with the points at issue—merely remarking that it is a very easy mode of avoiding the acknowledgment that he has been guilty of making a deliberate statement on hearsay, every word of which is untrue. I proceed to notice another instance of his *honorable* method of using the language of an opponent. With the view of casting farther doubts on my assertions, he says, pp. 135, 136, "I might dwell upon the admission by Mr. C., that the fact of the absence of corals from the Gallapagos, was not verified by him till the sheets of his article in the Boston Journal *were going through the press.* This fact was fully stated in my report, the reading of which has been so singularly forgotten, and the whole explained at some length; yet he only *verified* it when, long afterwards, his paper was in the press." This is his *statement.* Now for my *language*, on which it is based, or, more correctly, *not* based.

By turning to p. 382, of last volume, it will be seen, that I declare my knowledge of the absence of corals at the Gallapagos was derived from the commander and surgeon of the vessel in which I took passage from Sydney to Tahiti in the spring of 1840,—that not satisfied with the explanations of it given by the captain, I "was led to suspect that it would be found owing to the low temperature of the ocean," and that "*this* suspicion," (not the fact of the absence of corals there,) "however, I only verified while the sheets of my article were passing through the press." The fact of the absence of corals at the Gallapagos, I have never yet verified, excepting by the testimony of some whalemen whom I met at Tahiti, and I never considered that any other verification was necessary.

In view of his statement touching this pretended admission on my part, and of his former one made upon mere hearsay, which in *his* opinion is of no moment, I commend to Mr. D.'s consideration the following apposite quotation from a daily paper, alluding to charges affecting the character of another. "The hardihood and guilt of the assertion are equally great, by all codes of ethics, whether a man asserts *what he knows to be false*, or asserts what he does *not know* to be true." I apprehend that Mr. D. is very close to both horns of the dilemma.

See also Mr. D.'s foot-note to p. 131. "Mr. C. claims, in his vindication, that the whole subject of corals was in his hands, much to my surprise, and no doubt to the surprise of all who know that the structure of coral islands is so far a geological question as to constitute an important chapter in all geological treatises. The point was considered so far settled at sea as never to have been mooted."

Here Mr. D. clearly accuses me of having claimed the structure of coral islands, or the geology of corals, as having been placed in my hands. It is untrue that I ever advanced any such absurd proposition. This is what I said, p. 379, Vol. XLV, "It must be borne in mind, that in the distribution of the various departments of natural history among the naturalists attached to the expedition, the corals were especially assigned to me. Their habits, growth, distribution, and all else connected with their history, were consequently the subjects of my particular attention." Is it not self-evident that I here allude only to living corals, to corals zoologically considered, and call attention to the fact of their being assigned to me, as offering a reason why I should naturally have been led to observe the influence of temperature upon their growth? At the same time I neglected no opportunity of making observations on the geological structure of reefs and islands for Mr. D.'s information, and it was his knowledge of this which led to the proposition by him to publish on this subject jointly with me. I think, however, this was done just prior to our parting in Sydney, and not as he states at Oahu.

In another foot-note to p. 133, alluding to my statement that I found thirteen fathoms water, with a bottom temperature of 76°, upon *a* shelf profusely covered with coral, on which we suddenly came in approaching the island of Tutuila, Mr. Dana says,—"By referring to the log-book of the Vincennes, I find that *no temperature* was taken at *any depth* on the reef here referred to. The *thirteen fathoms* were obtained by a cast alongside of the reef; the reef itself on which the coral is growing, varies in depth from 4½ to 7 fathoms. (See expedition charts now publishing.)" The coolness with which all these particulars are applied to a shelf, *not a reef* of coral, whose locality I have only designated in general terms, is perfectly inimitable. But with all due respect for Mr. Dana's penetration and for the 'expedition charts now publishing,' I take leave to say that their reef with 4½ to 7 fathoms, and 13 fathoms alongside, &c. &c., is *not* "the reef here referred to" by me, which was a shelf of coral running out from the shore and gradually deepening, apparently from a few inches to thirteen fathoms. On this I sounded repeatedly, and obtained as nearly as I could estimate from the rude manner of my making the trial, 76° as a bottom temperature. The position and character of this shelf I shall specify hereafter. But, says Mr. D., 'by referring to the log-book of the Vincennes, I find that *no temperature* was taken at *any depth*.' By ingeniously substituting a *positive* statement on this head for a *negative* one, he changes the whole truth. He may not have found any record of the temperature taken; I should be astonished if there was one; but this is a widely different thing from finding a record that none *was* taken. Will Mr. D. point out any record in this log-book, of Dr. Pickering and myself measuring the distance from the ocean to the lagoon at Wilson's (or Peacock's) I.? any of my being ordered to ascertain the height of the mountain back of Tutuila, and of my clearing away a space on its summit as a mark of having reached it? or of my having at Upolu, made an excursion of over thirty miles in search of certain plains or savannas supposed to exist somewhere, measuring the altitude of all the peaks on the route, and making all possible observation on the topography of the island—by special order, to the neglect and detriment of my own appropriate duties? any of my illness and detachment at Sydney, of my rejoining at Oahu, of even my final detachment under orders to return home at this latter port? Nay, farther, will Mr. Dana pretend that from the day of our leaving the United States till that of my leaving the squadron in Nov. 1840, there are a dozen instances in which any excursion, duty, or experiment, made by any naturalist on board the Vincennes, is noticed ever so remotely in this log-book, whose silence is so triumphantly brought forward as conclusive testimony that my statements are untrue. *It seemed part of a regular system pursued towards the naturalists, to preserve as complete a silence in regard to all their actions as though they had formed no part of the expedition.* Indeed, I was repeatedly told on this subject, that the log-book was the record of the *ship's* business, *not ours*, (the naturalists.) More worthless evidence on any point touching their actions than Mr. D. has here paraded out, could not have been conjured up, and with this remark I dismiss his note.

One other note, p. 130, requires a few words. "Mr. Couthouy was with the squadron only about *one year and a half* of the *four* occupied in the cruise." For one who is so ready to accuse another of equivocation where none can be proved, yet who certainly in his last quoted paragraph on the record of the log-book, at least treads on the verge of it himself, this inaccurate statement, whatever may be its motive, comes with a very bad grace. I joined the squadron about the 8th of August, 1838. I continued attached to the expedition until 3d November, 1840, when I was ordered home from Oahu.

A few words touching his remarks on my public journals, p. 136, and I have done. That they are found, gives me no surprise whatever. Notwithstanding that they could no where be discovered when called for in evidence against Lieut. Wilkes, all who ever heard me allude to the matter can testify that I always expressed my firm conviction that they would be forthcoming when it was no longer an object to have them missing. I never for a moment credited the idea of their being lost. That they contain no theories or inferences from the facts recorded in their pages subsequently to our departure from Callao, I am very certain, inasmuch as after having had my own views therein contained, gravely quoted to me by another as the result of *his* reflections; I determined, thenceforth, while recording facts, to keep my deductions to myself till the time arrived for me to publish them. But, if what Mr. D. asserts be true, and there is "*not a word on the influence of temperature on the growth of corals*, nor any thing bearing the most remotely on this subject," then I unhesitatingly affirm that they have been mutilated. There is, or *was* in the first volume of these journals, a regular series of observations, giving the daily maximum and minimum temperature of the ocean from the time of our entering the Paumotu group till we reached Tahiti. These observations were made for this very purpose, and are, as I firmly believe, in the journal at this moment, although the reason of their being made is not stated. I *cannot* believe otherwise. But besides these, there were sealed up with the journal, numerous loose leaves and scraps containing memoranda, figures, dates, &c., thrown together and jotted down in a manner perfectly plain to *me*, though to any other person they would doubtless appear a congeries of unmeaning figures, without order or connection.

The seals of my field note-books, says Mr. D., *were broken for him*, and these, too, contained nothing. I ask the special attention of the reader to this statement, for 'thereby hangs a tale.' These journals and note-books, let it be known, were at the time I delivered them up in Oahu, secured each by several seals, bearing the impress of my own *private signet* as a safeguard against any improper tampering with their contents. These seals have been violated—broken open in my absence—broken open, too, for the benefit of my adversary. Who will dispute my right to repel indignantly any evidence obtained by such felonious means? How am I to know, who is to prove to me, that these seals were those affixed by *me*, that they had never been broken before, and the inconvenient testimony removed or *mislaid?* I again affirm, if these note-books indeed contain *nothing*, it is because *every thing* has been abstracted. Else, why was I not summoned to attend this opening of the books, this removal of my own private seal? I refer Mr. D. and his *honorable* coadjutors in the matter, to the common law and that of this state for a legal definition of this act. Were I to apply it, it might be considered 'vituperative.'

With this protest against the pretended evidence thus acquired, and which at best is but negative, I drop the subject, renewing my pledge to submit to the Association at its approaching session, such positive testimony as shall amply sustain all that I advanced in my reply to Mr. Dana's first charges, merely adding that I presume by this time the readers of this Journal are satisfied that "truth and honor," "character and right," each and all demanded of Mr. Dana a *somewhat* different course from that he has thought proper to pursue towards me.

Since the above was in type, Mr. Couthouy has sent us a list of temperatures taken from the ship's log-book, showing the daily maximum and minimum of the ocean (ranging from 77° to 83°) during the period from August 14 to September 10, 1839. This includes the time from the day of the squadron's arrival in the Paumotus, to that of its anchoring in Tahiti. We have not room for the table itself.—Editors.

## *Reply of J. D. Dana to the foregoing article by Mr. Couthouy.*

Mr. Couthouy in his preceding remarks, has made out a somewhat plausible story, yet not to the total concealment of the truth. When an opponent is reduced to such extremities as dwelling upon the use of the pronouns "*we*" and "*us*," or quibbling about the phrases "*abstract*" and "*duplicate minutes*"—when he finds it necessary for his case, to affirm what he has before denied and deny his former affirmations, to twist and torture his yielding phrases till they no longer look like themselves, we may well question his conclusions, although "solemnly declared on his faith and honor as a man." But not to deal in assertions alone, we may glance at a few particulars in the above reply.

Perhaps its most striking feature is the subdued tone with which the subject is approached. A second, no less prominent, is the implied admission of many points before forgotten:—for example, *the reading of my report—the agreement to coöperate in our observations*, &c. Not to dwell on these peculiarities, we may pass in rapid review a few of his more cogent arguments and then dismiss the subject.

For a reply to his observations upon "misused confidence," we need only refer to his previous article. The many words on former friendly deeds are quite wasted, as the friendship and confidence between us had already been asserted and admitted on both sides. That his conscience should have slumbered for a while is natural; his own unkindness would not banish at once the remembrance of the past. I may again ask, What is that friendship that could publish at all on the subject of corals after the understanding—now acknowledged—that we should coöperate in our investigations and Report? What the honorable feeling that could violate such obligations—sacred, at least, among professed friends? Suspicions might reasonably be aroused after *such* a friendly deed.

It pains me thus to deal with one whose friendship once was valued, with whom kind acts were long reciprocated. But, as the case stands, there is little virtue in withholding the truth. I proceed then to notice a fact which will serve as a key for interpreting the rest of Mr. Couthouy's reply.

In the course of the attack in Vol. xlv of this Journal, Mr. C. alludes more than once to the "*duplicate minutes*" which contained "the most important of his observations" at sea, and afforded the facts on the temperature of the ocean inserted in his article on corals. In the preceding reply, we learn more definitely that these "*duplicate minutes*" (which he objects to having called an "*abstract*") "are scattered in disjointed fragments through some 1400 pages of MSS." (p. 2); and, he adds, "such an abstract as could be made, had already been brought forward in the very article which has given rise to this discussion." Let the reader turn now to the original article, 'which gave rise to this discussion,' page 77, at bottom,* and read: "*My observations in MS. on this subject are now in the possession of the Navy Department at Washington; but not being permitted to have access to them, I am compelled in all the statements made in*

* Boston Journal, Vol. IV.

*this communication to* RELY UPON MEMORY *alone*." It is not here said, *all the statements in a particular paragraph*, or *on a particular page*, or *relating to a particular subject*, but, 'ALL, IN THIS COMMUNICATION.' From this, we may judge of the credit due to other statements. As stated, it is a key to this and his former reply. After this exposure, his other charges can scarce require more than a simple denial.

As to *geological facts*, the reader may refer to the article itself, and read some pages on the elevation of islands in the Pacific, their vallies, &c.

Respecting the whole subject of corals belonging to him, his own citation, "all else connected with their history," conveys but one idea to the reader of his attack.

On page 7 of this appendix, Mr. Couthouy says, "I neglected no opportunity of making observations on the geological structure of reefs, and it was his (Mr. Dana's) knowledge of this, which led to the proposition by him to publish on this subject jointly with me." Let facts tell the tale. Mr. Couthouy had the *zoological* branch of the subject, and notwithstanding his 'traversing the same ground with Mr. Dana, possessed of equal facilities for observing the phenomena presented by corals, with the same facts presented to his notice,'* he had not figures of more than a dozen species of corals, on reaching the Sandwich Islands. The contents of my portfolio have already been alluded to; there were colored drawings of the animals of more than a hundred species, and more than a score of written sheets were occupied with my geological observations. I had seen Mr. C.'s drawings, but had never given his geological investigations on corals a thought. His journal to the Samoa group contains almost nothing on this subject. Farther words are unnecessary.

The reef referred to off Tutuila, was often described to me by Mr. Couthouy while at sea, its position pointed out, and the supposed fact of its being covered with coral in thirteen fathoms dwelt upon. The ship obtained a cast of the lead in thirteen fathoms on the edge of the reef, and as it was small, was just leaving it, when the lead was dropped again to the same depth. It was afterwards sounded by the boats and found to be covered with four and a half to six fathoms of water.

The second foot-note to page 5, renders any remarks on the charge to which it refers, quite unnecessary.

The *second* paragraph on page 6 will be found sufficiently refuted by recurring to the pages he has there referred to.

It is still true that Mr. C. was with the squadron but a *year and a half*. He left it at Sydney, New South Wales, and went by a private opportunity to the Sandwich Islands, and was not with us during the summer of 1840, at the Feejee group, the richest coral region met with in the Pacific. Only *sixteen months* had elapsed since our departure, when we left Samoa, where his "duplicate minutes" ceased.†

As to the mutilation of the journal:—while examining it, I prudently counted leaves and pages: from the Paumotus to Samoa nothing was missing. The seals opened, were broken in the presence of witnesses

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* See Mr. C.'s reply, p. 379, Vol. XLV, of this Journal.
† See this Journal, Vol. XLV, p. 380.

by those who had authority, if there is power in government to break the seals of reports sent in by their employés.—The table of temperatures referred to, which is not given in the regular course of the journal, covers only a few hundred miles of ocean. Did I not know it from actual intercourse with Mr. C., there would still be reason enough to conclude from his suspending it so soon after entering the coral seas, and his mistakes, before exposed, respecting the "flourishing" and "limiting" temperatures—that it was not made with any reference to this subject. It embraces a few facts in log-book fashion, which, though taken about the coral islands, contain none of the views in dispute. It is somewhat surprising that Mr. Couthouy refers to these alone, and cites nothing from his "duplicate minutes" bearing more directly upon his claims.

The insinuation in the third paragraph on page 8, excites rather pity than contempt. Mr. Couthouy if charged with it, would probably deny any reference to me; but the reader perceives the bearing and intent of the italicised *his*.—An allusion to the "peculiar intimacy" dwelt upon by him so warmly, and acknowledged to have continued *long after* "*our departure from Callao*"—and not even to have been suspended at the Sandwich Islands, where my Report was read to him, is all the reply I make.*

His readers may perhaps appreciate Mr. C.'s regret, that this subject was not permitted to rest till the Geological meeting in May.

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* See pp. 387, 388, Vol. XLV of this Journal; page 3 of the appendix.

## ACKNOWLEDGMENTS TO CORRESPONDENTS, FRIENDS AND STRANGERS.

*Remarks.*—This method of acknowledgment has been adopted, because it is not always practicable to write letters, where they might be reasonably expected; and still more difficult is it to prepare and insert in this Journal, notices of all the books, pamphlets, &c., which are kindly presented, even in cases, where such notices, critical or commendatory, would be appropriate; for it is often equally impossible to command the time requisite to frame them, or even to read the works; still, judicious remarks, from other hands, would usually find both acceptance and insertion.

In public, it is rarely proper to advert to personal concerns; to excuse, for instance, any apparent neglect of courtesy, by pleading the unintermitting pressure of labor, and the numerous calls of our fellow-men for information, advice, or assistance, in lines of duty, with which they presume us to be acquainted.

The apology, implied in this remark, is drawn from us, that we may not seem inattentive to the civilities of many respectable persons, authors, editors, publishers, and others, both at home and abroad. It is still our endeavor to reply to all letters which appear to require an answer; although, as a substitute, many acknowledgments are made in these pages, which may sometimes be, in part, retrospective.—*Eds.*

### SCIENCE.—FOREIGN.

Catalogue of British Fossils, by John Morris. London, 1843. pp. 222, 8vo. From Dr. G. A. Mantell.

Geology of the voyage of H. M. S. Sulphur, under the command of Capt. Sir Edward Belcher, R. N. Mammalia by John E. Gray, Esq., F. R. S. London, 1843. Pamph. 4to.

Transactions of the Royal Society of Edinburgh. Vol. 15, part 3. 1843. From the Society.

Proceedings of the Philosophical Society of Glasgow, 41st session. 1842–3. From the Society.

Dent on the Depleidoscope. From the author.

Lecture on Animal Electricity, by H. Lettresby, M. B., curator of the Museum.

Manipulations in the scientific arts. Electrotype manipulations, parts 1 and 2, by Charles V. Walker. London, 1843. Received Nov. 16.

Fourth annual report of the Registrar General of births, deaths, and marriages in England. London, 1842. pp. 362, 8vo.

Nuove ricerche ed observazioni intorno all avvelenamento ciandrico imputato al Signor A. Heritier, Consultazione di Girolamo Botto professore di Clinica e Nosologia practica Nella Regia Università di Genova. Genova, 1842. From Edward Lester, United States Consul.

Revista Ligure, anno primo fascicolo 1 and 7. Genova, 1843. From the editor, through the U. S. Consul at Genoa, Edward E. Lester.

Schriften der in St. Petersburgh Gestiftenten Russisch-Kaiserlichen Gesellchaft Für die Gesammte Mineralogie. 1r band, 1ste Arbtheilung mith Steindrucktafeln. St. Petersburgh, 1842. Also 11th Arbtheilung. From Charles Cramer.

Arsberättelse on Framstegen. 1 Fysik och Kemi afgifen den 31 Mars, 1840; af Jac. Berzelius, Stockholm, 1840.

Do. om Technologiens framsteg; af G. E. Pasch. Stockholm, 1841.

Tal om Jordbrukets närvarande tillstånd inom fäderneslandet, hindren för dess förkofran och utsigterna för dess framtid, Hallet 1. Kongl. Veteneskaps-Academien vid Presedii Nedlaggande den 6 April, 1842; af August Auckarswärd. Stockholm, 1842.

The Quarterly Journal of Mineralogy and Physical Science. Published by J. W. G. Gurch, M. C. R. S. Lond., 1843. From the Publisher.

The Chemist. Nov. 1843.

Memoirs of the Chemical Society of London, 1841–43. Vol. 1, 8vo. London, 1843. From the Society.

SCIENCE.—DOMESTIC.

Natural History of New York. Report on the geology of the first geological district, by Wm. W. Mather. 4to volume. From the Author.

The Encyclopedia of Chemistry, by James C. Booth and Martin H. Boyé. Carey & Hart, Philadelphia. Nos. 1 and 2.

American Philosophical Society. Celebration of its Hundredth Anniversary, May 25, 1843.

Proceedings of the Boston Society of Natural History. Regular meetings, from Jan. 6, 1841, to June 21, 1843. 2 copies.

Northern Academy of Arts and Sciences. Hanover, July 25th, 1843. 2 copies.

A new edition enlarged and improved of the Bommer method of making manure, by Dr. Eli Ives. New York, 1843.

Principles of Human Physiology, by W. Carpenter, M. D.; with notes and additions, by M. Clymer, M. D. Philadelphia, 1843. pp. 620, 8vo.

An essay on organic remains as connected with an ancient tropical region of the earth, by Thomas Gilpin, Esq., Mem. Am. Phil. Soc. Philadelphia, 1843. From the Author.

Boston Journal of Natural History. Vol. 4, No. 3. 1843.

MISCELLANEOUS.—DOMESTIC.

Catalogue of the Officers and Students of Brown University. Providence, 1843. From Prof. G. I. Chase.

Do. of Dartmouth College. Hanover, N. H., 1843. From Prof. O. P. Hubbard.

Do. of Harvard University. Cambridge, Mass. 1843. From Prof. H. W. Longfellow.

Do. of Middlebury Colloge. Middlebury, Vt. 1843. From Prof. C. B. Adams.

Congressional Document—the letter of the Secretary of the Treasury on the Commerce and Navigation of the United States, 1842. From Hon. L. Saltonstall.

Report of Mr. Kennedy of Maryland on the memorial of friends of American Colonization, Feb. 1843. From Hon. Mr. Clark, M. C.

An address delivered before the Washington and Lafayette Societies of Lafayette College, Easton, Pa. at the eighth annual Commencement, Sept. 1843, by Wm. A. Porter of Philadelphia.

Report of the Providence Athenæum at their eighth annual meeting, Sept. 1843.

Mr. Tyson on the Colony of Pennsylvania prior to 1743. Read before the Am. Phil. Society at their hundredth anniversary. From the Author.

An inaugural discourse on Arabic and Sanskrit Literature delivered in New Haven, Aug. 16, 1843, by Prof. E. E. Salisbury. From the Author.

An address by Pres. Lathrop on the occasion of the dedication of the Chapel of the University of the State of Missouri, July, 1843.

An address on the power and progressiveness of knowledge, by Rev. S. B. Canfield of Ohio City. Painesville, Ohio, 1843.

Plain instructions to preserve from rust, wrought and cast iron and steel; also the method to cover iron with a surface of copper, and the method to prepare galvanic powder and paint, by George Johnson, formerly free merchant of Calcutta. New York, 1842.

Genuine radicalism, an address delivered by Dr. D. H. Riddle before the Goethean and Diagnothian Societies of Marshall College, Penn. 1843. From the Author.

An address by Rev. T. Lafon, M. D. on the great obstacles to the conversion of souls at home and abroad. New York, 1843.

Endemic influences of civil government, illustrated in a view of the island of Minorca, by J. A. Foltz, A. M., M. D., Surgeon U. S. N. pp. 65, 8vo. From the Author.

Cultivator Almanac, 1844. Lansingburgh.

Circular of the American Institute, New York.

First lines of English Grammar, by Gould Brown. New York.

An address before the Essex Agricultural Society, by the Hon. L. Saltonstall. Salem, 1843. 2 copies from the Author.

Southern Literary Messenger for Nov. and Dec. 1843; the latter containing a handsome complimentary notice of the American Journal of Science. From the Editors.

### MISCELLANEOUS.—FOREIGN.

A piece of music from John Taylor, Esq., Liverpool. Air by Mozart—words translated by Mr. T. from the Italian. "Never more shalt thou go."

Booksellers' catalogues, from Wiley & Putnam, New York and London; University Press, Oxford; from Appleton & Co., N. Y.; Charles Dolman, London; J. Y. Techel, do.; B. R. Wheatley, do.; Miller, do.; Dan. Fanshaw, Phil.

Proceedings of a meeting of citizens of the United States in Paris, at the Athenée Royale, March, 1843, with an address upon the literary exchanges recently made between France and the United States, by A. Vattemare. Paris, 1843. De l'Auteur.

### NEWSPAPERS.—DOMESTIC.

Several Nos. of the Christian Freeman, Hartford, Ct. The Planters' Banner, Franklin, Attakapas, La., Oct. 1843. Buffalo Gazette, Nov. 20, 1843. Painesville Telegraph, extra, Oct. 1843. Willoughby University of Lake Erie. The Ohio Observer, Hudson, Oct. 5, 1843. Alexandria Gazette, from T. Blagden, Esq. The Jeffersonian, Watertown, N. Y. The Mercury, Charleston, resolutions passed on the death of Albert Rhett, Esq. Cleveland Daily Herald. The Christian World, Boston, containing an article on the late Washington Allston, by Dr. Channing. The Impartial, Vermilionville, with a notice of Yale College.

### NEWSPAPERS.—FOREIGN.

The Non-Conformist, London, July, 1843. The Jersey and Guernsey News, Jersey, Oct. 1843. From Dr. Mantell.

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BENJAMIN SILLIMAN, Jr.

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OF

# SCIENCE AND ARTS,

CONDUCTED BY

PROF. B. SILLIMAN AND B. SILLIMAN, JR.

OF YALE COLLEGE.

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*To the Friends of Science, and more particularly to the Subscribers and Patrons of the American Journal of Science and Arts, from the Editors.*

WE beg leave to present to your consideration the following statement. The American Journal has been sustained during twenty five years; a generation of men has almost passed away, while death and misfortune have nearly cancelled the original subscription, which has however, from time to time, been recruited by many additional names; but the severe pecuniary vicissitudes of the last six years, (affecting also, as we regret to learn, our literary cotemporaries,) have again crippled our subscription list, which is now barely sufficient to pay the expenses of the publication of the Journal; and any considerable additional diminution might place its existence in hazard.

In two former periods of exigency, a frank disclosure was made to our subscribers and to the public, and we hesitate not to do it again, deeming it no personal humiliation, but an act of fidelity to the honor and the welfare of our country.

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